

INSTITUTE OF MATHEMATICS
FOR INDUSTRY,
KYUSHU UNIVERSITY

FY2023

Self-Assessment

Report

FY2023
Institute of Mathematics for Industry,
Kyushu University

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Preface

Mathematics can be likened to an unquenchable light that illuminates the darkness in today's highly functional society. In fact, mathematics is the cornerstone of almost all of the advanced technologies that drive modern society, including information security, networking, medical technologies such as CT scans and MRIs, aircraft and car development, blast furnace and nuclear reactor control, scheduling in the transportation and distribution industries, finance and insurance, resource exploration, disaster prediction, and entertainment. The essential foundation stone of almost all of the advanced technologies that drive modern society is mathematics. In the past, mathematics was used in society through various scientific fields such as theoretical physics, and there was a time when the application of mathematics = the application of mathematics to physics. However, with the emergence of “big data” at the beginning of this century, the discovery of deep learning in the 2010s, and the explosive development of AI technologies and data science, various types of mathematics with high levels of abstraction are now directly applied to society without going through physics. Now, more than ever, there is a need for researchers in mathematics and mathematical sciences in many fields of science and technology, and the quality and quantity of such researchers are directly influencing national power. There is no doubt that this demand will increase internationally as well.

The Institute of Mathematics for Industry (IMI) at Kyushu University was established on April 1, 2011 as Asia's first research institute for mathematics-for-industry based on diverse mathematical research, in order to respond to such demands from Japan and the international community.

On April 1, 2013, IMI was accredited by the Minister of Education, Culture, Sports, Science and Technology (MEXT) as an “Joint Research Center for Advanced and Fundamental Mathematics-for-Industry” under the MEXT Joint Usage and Research Center.

This report summarizes IMI's activities from its establishment (2011) to the present (October 1, 2023), and clarifies what IMI has accomplished and what is needed for its sustainable development in the future.

1. Philosophy, Targets and History

1.1 Philosophy

Mathematics for Industry (Mfi) is a new research field of mathematics that will serve as a foundation for the creation of future technologies, and is created by integrating and reorganizing pure and applied mathematics into a fluid and versatile form to meet the demands of industry. Mfi seeks to discover the seeds of new mathematics while responding to the challenges of society and industry, to shed new light on and integrate existing and often forgotten mathematics to solve problems, and to develop new and rich mathematics using the awareness of external problems as one of the driving forces. Therefore, Mfi requires both “deep and fundamental research in mathematics” that discovers and strongly develops the seeds of mathematics, and “high-impact research in mathematics” that is strategic, agile, and high-impact.

1.2 Targets

The Institute aims to be the world's top institute for industrial and applied mathematics, realizing the philosophy of Mfi, and sets the following goals.

- Strong basic research and application development that responds to the needs of society and leads change.
- Inviting and providing opportunities for strong researchers by utilizing cross-appointments.
- Establishment of a strong domestic and international network.
- Research institutions created in cooperation with the research community, industry, the local community, and the international community.
- Fostering human resources for mathematical research and supporting education, including junior and senior high school students.
- Establishment of a strong management system that enables the above activities while securing research time for faculty members.

In addition, the following activities will be carried out to achieve the above goals.

- Joint research that meets the needs of industry at home and abroad, and a variety of mathematics research that supports such joint research
- Fostering young researchers, especially excellent human resources who can play an active

role as leaders with mathematics as a weapon in the global arena, including various scientific fields and industry

- Matching and management of internships (long-term doctoral program, mid-term master's program)
- Education and outreach activities from the aspect of mathematics useful to society (Graduate School of Mathematics, Graduate School of Mass-for-Innovation Studies, and Department of Mathematics, Faculty of Science)
- Planning and management of joint research as a center for joint use and joint research
- Construction and operation of a platform to respond to the demands of society through an all-Japan system
- Planning and operation of academic meetings such as workshops, international conferences, seminars on industry-academia collaboration and interdisciplinary cooperation, tutorials on key technologies in mathematics, etc.
- Planning and operation of study groups (short-term intensive research meetings aimed at solving unsolved problems in industry and other fields)
- International collaboration with an emphasis on ties with the Asia-Pacific region
- Publication of the International Journal of Mathematics for Industry, Proceedings of international conferences, Lecture Note Series, and Preprint Series
- Other projects to realize the philosophy of MfI

1.3 Establishment of Divisions

IMI operates on a “division system” with faculty members belonging to each division and engaging in their own research activities.

Some of the divisions specialize in joint research with partner companies and some specialize in IMI management, while others have closed due to the expiration of their collaborative activities.

The divisions established at IMI as of October 1, 2023 are as follows.

Division of Advanced Mathematics Technology

This department promotes joint research with companies and researchers in other fields. Researching groundbreaking mathematical technologies, it works to solve mathematical problems that companies have by joint or commissioned research.

Division of Applied Mathematics

This department develops mathematical methods to refine existing mathematical

techniques and investigates theories having broad application to demonstrate the universality of mathematics. The members of this department will perform joint research on occasion with members of industry and researchers in various scientific fields and will promote theoretical research with an eye to application.

Division of Fundamental Mathematics

This department is staffed with pure mathematicians having an interest in application, who, in cases where the problem is clear but the mathematical technique for solving the problem is not, perform basic research to clarify that technique. The department performs basic research to drive technical innovation.

Division of Intelligent Societal Implementation of Mathematical Computation

This division implements cutting edge mathematical technologies for highly convenient social designs in large scale through collaboration with many industrial partners, and thus leads IMI's industry-academia cooperation. By creatively amalgamating leading techniques in mathematical modeling with AI, we contribute to the construction of ultra-smart society based on Society 5.0.

Division of Industrial and Mathematical Statistics

In the division of Industrial and Mathematical Statistics, along with we cooperate with researchers in statistics and related fields inside and outside the university to deepen the scientific principles of statistics and related fields, in society, industry, and various scientific fields, we will play a role in contributing to solving various problems. In addition, in response to the needs of society, we will carry out human resource development projects related to statistics and related fields both inside and outside the university under the governance of the university.

Laboratory of Mathematical Design for Advanced Cryptography

Recent advances in information and telecommunication technologies bring forward new applications of cryptographic theory. In turn, newly developed cryptographic methods and constructions as well as their security evaluation require application of a wide range of mathematical theories, beyond those conventionally used for cryptography. The Laboratory of Mathematical Design for Advanced Cryptography, leveraging the cooperation between academic research institutes, industry and the governmental institutions, aims at development of the next-generation cryptographic technologies featuring a wide variety of secure functionalities, with the ultimate goal of

achieving safe and sustainable society. Through the cooperation between academia, industry, and the governmental institutions, the Laboratory will continue to promote the newest advances in mathematical cryptography towards design and development of the next-generation cryptographic constructions meeting the highest international standards.

Division of Strategic Liaison

The Division of Strategic Liaison establishes an optimal system to meet the rapidly growing needs of society, industry, and academic fields by carrying out the following three missions:

- (1) strengthening the promotion and support functions of joint research,
- (2) operating the Mathematics for Industry Platform (MfIP), and
- (3) pursuing joint research in a practical manner.

Australia Branch

Australia Branch was established in La Trobe University (Melbourne, Australia) in March, 2015, and is managed by the academic staffs employed in Australia to be the hub for promoting the activities such as joint researches with institutes in Oceania area, student exchanges and international internships. It also coordinates the cooperation with major research institutes in Australia and New Zealand.

Division of Fujitsu Mathematical Modeling for Decision Making

This department promotes research on social modeling and analysis for decision making in real world through the collaboration with Fujitsu Limited.

1.4 Director History

Name	Period
Masato Wakayama	2011/4/1 ~ 2014/9/30
Yasuhide Fukumoto	2014/10/1 ~ 2018/9/30
Osamu Saeki	2018/10/1 ~ 2022/9/30
Kenji Kajiwara	2022/10/1 ~ Present

2. Medium-Term Objectives and Plans

IMI was established in FY2011. This corresponds to the “second phase” in terms of the period of the Mid-term Objectives and Mid-term Plan. Since then, IMI, like other departments, has been formulating its Mid-term Objectives and Mid-term Plan.

The latest version of the “Fourth Medium-Term Objectives and Plans” is attached for your reference, while the attached plan is organized in Japanese only.

[References: 4th_IMI_plan.pdf]

3. Organization & Budgets

3.1 Faculty and Administrative Staff (effective October 1, 2023)

IMI consists of “faculty” affiliated with the Firm, “visiting faculty” consisting of external members, “academic researchers”, and “administrative staff”. The details of the IMI's faculty members, visiting faculty members, and academic researchers (as of October 1, 2023) are as follows.

Division of Advanced Mathematics Technology

Official title	Name
Professor(s)	Naoyuki Kamiyama
Associate Professor(s)	Nguyen Dinh Hoa Daisuke Tagami (concurrent)

Division of Applied Mathematics

Official title	Name
Professor(s)	Yasuhide Fukumoto Kenji Kajiwara Yoshihiro Mizoguchi
Associate Professor(s)	Atsushi Tero Hayato Waki
Assistant Professor(s)	Hiroshi Takase Takeo Uramoto

Division of Fundamental Mathematics

Official title	Name
Professor(s)	Hiroyuki Ochiai Osamu Saeki Tomoyuki Shirai
Associate Professor(s)	Noriyuki Hamada Yasuhiro Ishitsuka Hisatoshi Kodani Akiko Yazawa

Division of Intelligent Societal Implementation of Mathematical Computation

Official title	Name
Professor(s)	Katsuki Fujisawa Shizuo Kaji Ryoko Tomiyasu Naoyuki Kamiyama (concurrent) Yoshihiro Mizoguchi (concurrent)
Assistant Professor(s)	Mikihiro Fujii

Division of Industrial and Mathematical Statistics

Official title	Name
Professor(s)	Kei Hirose Hien Duy Nguyen Katsuki Fujisawa (concurrent)
Associate Professor(s)	Yuichi Ike
Assistant Professor(s)	Masayo Hirose Sumito Kurata

Laboratory of Mathematical Design for Advanced Cryptography

Official title	Name
Professor(s)	Koji Nuida Katsuki Fujisawa (concurrent) Yoshihiro Mizoguchi (concurrent)
Associate Professor(s)	Hayato Waki (concurrent)
Assistant Professor(s)	Yasuhiko Ikematsu

Division of Strategic Liaison (Established in April 1st, 2023)

Official title	Name
Professor(s)	Kaname Matsue Katsuki Fujisawa (concurrent) Kei Hirose (concurrent) Shizuo Kaji (concurrent) Naoyuki Kamiyama (concurrent) Katsuhiko Furukawa (Academic Research and Industrial Collaboration Management Office, concurrent)
Associate Professor(s)	Daisuke Tagami Akifumi Kira

Australia Branch

Official title	Name
Professor(s)	Kenji Kajiwara (concurrent)
Associate Professor(s)	Pierluigi Cesana Daniel Gaina

Division of Fujitsu Mathematical Modeling for Decision Making

Official title	Name
Professor(s)	Kei Hirose (concurrent) Shizuo Kaji (concurrent) Naoyuki Kamiyama (concurrent)
Assistant Professor(s)	Yasuhiko Ikematsu (concurrent)
Guest Professor(s)	Tetsuro Takahashi (Kagoshima University)

Graduate Program of Mathematics for Innovation

Official title	Name
Associate Professor(s), special research project	Yasuhiro Ishitsuka Takeo Uramoto

In addition, 24 visiting faculty members and 5 academic researchers

The administrative department is responsible for the science department and other departments, i.e.

- Faculty of Science
- Graduate School of Science, Graduate School of Mathematics, IMI
- Joint Graduate School of Mathematics for Innovation, Graduate School of Systems Life Science.

There is a Common Administrative Office that is involved in the administration of the Faculty of Science, and its staff, nearly all of whom number over 100, are involved in the administration of the above-mentioned departments, including IMI. In this section, only the staff of the Common Administrative Division with positions and the staff in charge of IMI in “the Mathematics and IMI Office” are described.

Affairs Departments (Common Affairs Departments in the Faculty of Science)

Official Title	Name • Members (number of people)
Director of Administration	Jun Matsuo
Dean: Faculty of Science	Akira Terasaki
Director of General Affairs Division	Kazunari Naganoma
General Affairs Division	General Affairs Section (5) Head: Naomi Matsuo Senior Administrator: Masataka Kobayashi

	<p>Human Resources Section (5) Head: Takahiro Yasukochi Senior Administrator: Chiemi Kawashima</p> <p>Research Support Section (5) Head: Maiko Hagihara Senior Administrator: Takuto Imato</p> <p>Information Infrastructure Office (2) Research Assistant Professor: Ryosuke Nakashima</p>
Director of Financial Affairs Division	Yoshiharu Hayashi
Financial Affairs Division	<p>Accounting Section (9) Head: Kengo Inomata Senior Administrator: Kana Harada</p> <p>Supplies Section (7) Head: Masaki Watanabe Senior Administrator: Masataka Tateno Senior Administrator: Munemi Katsuki</p> <p>Preservation Section (2) Head: Hironori Okazaki</p>
Director of Academic Affairs Division	Seiji Mori
Academic Affairs Division	<p>Student Support Section (5) Head: Chika Ishibashi, Senior Administrator: Maiko Kameoka, Senior Administrator: Eri Nagashima</p> <p>Student Affairs Section (6) Head: Katsuya Kugo Senior Administrator: Toshihiro Irie</p> <p>Global Relations Office (3) Specialist: Chiharu Inazawa</p>
Office of Research Support Services in Graduate Program of Mathematics for Innovation	<p>Office of Research Support Services (5) Head: Hiroshi Morotomi Specialist: Harumi Yoshida</p>
Section of University Museum, etc.	<p>Section of University Museum (4) Fujii Gallery (2)</p>

Administrative Division (Mathematics and IMI Office)

Official Title	Name
Chief clerk	Atsuko Sono
Secretary to the Director	Seiko Sasaguri

Joint Research Center for Advanced and Fundamental Mfl	Mika Tomonaga Asami Yoshitake Kanakano Sujaku
	Kyoko Ikebe Aya Iwashita Yukiko Takahashi Mami Domoto Keiko Koga Shizue Kinoshita Yuko Nishijima Miyoko Nonaka Etsuko Suyama Kumiko Nakashima Takako Iida Yuko Yokoo Masako Yamashita

3.2 Budgets

The financial resources that support IMI's activities are diverse.

•Operating Subsidy

These are the basic expenses allocated by the university as a whole. The main source of income is tuition fees, but a portion of the indirect costs associated with obtaining Grants-in-Aid for Scientific Research (see below), as well as the cost of activities for the Joint Usage/Collaborative Research Center Project, which is added when a request for budget is approved, is also included in the grant and is generated from this source.

•Scientific Research Funding for Career (KAKENHI)

Researchers affiliated with IMI apply for Grants-in-Aid for Scientific Research (KAKENHI) from the Japan Society for the Promotion of Science (JSPS) and obtain a large number of research funds.

Direct costs are allocated to each researcher and indirect costs are allocated to Kyushu University (incorporated into the operating subsidy), a part of which is allocated to IMI. The amount of acquisition is discussed in Chapter 6.

•Funded/Collaborative Research

In addition to the Grant-in-Aid for Scientific Research, researchers affiliated with IMI obtain research funds from JST (Japan Science and Technology Agency) project research funds such as CREST and the Future Society Creation Project, as well as from joint research contracts with many companies. The research funds allocated for funded research are used to cover the

activities of the Joint Research Division, etc. A portion of the funds for joint research is allocated to Kyushu University as an indirect cost, and a portion of this is allocated to IMI. This is similar to that of the Grants-in-Aid for Scientific Research.

Chapter 6 discusses the trends in the amount of funds obtained.

• Request for budgetary appropriations.

Activity expenses for the establishment of new divisions, etc., to be developed as new IMI projects independent of joint research with companies, etc., will be supplemented by an estimated budget request, which will be adopted. Until FY2021, “Special Expenses” based on an estimated budget request were approved and informal announcements were made as shown in Table 3.1. These budgets are also an important source of funding for IMI.

Budget payments are made over a fixed period of years, but the amounts allocated for each year are listed because the amounts differ from year to year.

In FY2022 and thereafter, IMI submitted a budget request for “organizational development” and received funds (over 50 million yen) for the establishment of the “**Division of Industrial and Mathematical Statistics**”. In FY2023, a budget was allocated for the foundation of the “Division of Strategic Liaison”, which will be launched in the same year. This budget was approved as an expansion of the budget for the establishment of the “**Division of Industrial and Mathematical Statistics**” and is scheduled to continue until FY2026.

Table 3.1: History of Estimated Requests and Offered Amounts

Year	Requirement	informal amount (Yen)
FY2013	Joint Research Center for Advanced and Fundamental Mathematics-for-Industry	18, 500, 000
	Formation of an international research hub for mathematics-for-industry that connects the needs of society and industry with the research seeds of universities - Fundamental research and implementation of results in mathematics-for-industry, development of new mathematical fields, and fostering new types of mathematics researchers -	37, 076, 000
FY2014	Joint Research Center for Advanced and Fundamental Mathematics-for-Industry	15, 321, 000
	Formation of an international research hub for mathematics-for-industry that opens up and connects the needs of society and industry with the research seeds of universities	25, 953, 000
FY2015	Joint Research Center for Advanced and Fundamental Mathematics-for-Industry	14, 571, 000
	Formation of an international research hub for mathematics-for-industry that opens up and connects the needs of society and industry with the research seeds of universities	18, 167, 000
FY2016	Joint Research Center for Advanced and Fundamental Mathematics-for-Industry	24, 877, 000

	Formation of an international research hub for mathematics-for-industry that opens up and connects the needs of society and industry with the research seeds of universities	15, 385, 000
FY2017	Joint Research Center for Advanced and Fundamental Mathematics-for-Industry	24, 877, 000
	Formation of an international research hub for mathematics-for-industry that opens up and connects the needs of society and industry with the research seeds of universities	15, 385, 000
FY2018	Joint Research Center for Advanced and Fundamental Mathematics-for-Industry	25, 727, 000 (* 1)
	Creation and innovation of social design mathematics to meet the needs of a super-smart society	9, 800, 000
FY2019	Joint Research Center for Advanced and Fundamental Mathematics-for-Industry	25, 227, 000
	Creation and innovation of social design mathematics to meet the needs of a super-smart society	9, 800, 000
FY2020	Joint Research Center for Advanced and Fundamental Mathematics-for-Industry	25, 227, 000
	Creation and innovation of social design mathematics to meet the needs of a super-smart society	9, 800, 000
FY2021	Joint Research Center for Advanced and Fundamental Mathematics-for-Industry	25, 227, 000
	Creation and innovation of social design mathematics to meet the needs of a super-smart society	9, 800, 000
FY2022	Project for Formation of Cross-disciplinary Mathematical Infrastructure to Boost Social Transformation through Integrated Knowledge ~IMI•Establishment of Division of Industrial and Mathematical Statistics ~	54, 540, 000
	Joint Research Center for Advanced and Fundamental Mathematics-for-Industry	18, 435, 000
FY2023	Project for Formation of Cross-disciplinary Mathematical Infrastructure to Boost Social Transformation through Integrated Knowledge	90, 020, 000 (* 2)
	Joint Research Center for Advanced and Fundamental Mathematics-for-Industry	18, 435, 000

(* 1) The original informal amount was 18,927,000 yen, but there was a reallocation due to the interim evaluation, and an additional 6,800,000 yen was added. The total amount is shown here.

(* 2) This amount is the sum of the project budget of the “**Division of Industrial and Mathematical Statistics**” and the project budget of the “Division of Strategic Liaison”.

Remark: In addition to the above requirements, before the establishment of IMI: Special funds were allocated from FY2010 to FY2015 under the following proposal names:

“International Standards in Graduate Mathematics Education - Construction and Development of Graduate Level Mathematics Education for the International Community”

This expense was allocated as a “special mathematical expense” that should have been included in the budget of the Institute of Mathematical Sciences, not IMI. In addition to being combined with the Graduate School of Mathematics, the administrative system was still in the process of being organized until FY2013, so we were unable to find documentation of the unofficial announcement and were not able to accurately reconcile the unofficial amount. Therefore, no specific reference is made in the above table.

•University Reform Activation System

Kyushu University has a “University Reform Activation System”. Under this system, faculty members compete to submit reform plans, and the university allocates “Points” to the best plans as a special measure to enable them to be hired as faculty members. Many faculty members have been assigned to IMI as a result of receiving points under this program, and this program can be regarded as a part of the budget acquired in terms of faculty assignment measures. Some of them applied for IMI alone, while others applied for IMI in multiple departments.

Table 3.2 Details of Applications and Measures under the University Reform and Activation System

Year	Department	Classification	Reform Plan	Measure	Application Content
FY2012	IMI	-	Reorganization of the department and establishment of the Advanced Mathematical Theory Software Development Office	1 Associate Prof.	-
FY2014	IMI	-	Establishment of “IMI Australia Branch”	1 Associate Prof., 1 Assistant Prof.	-
FY2015	IMI	-	Establishment of “ Laboratory of Mathematical Design for Advanced Cryptography ”	1,373 Points (Compensating 1 Associate Prof. and 1 Assistant Prof.)	-
FY2016	RIIT, Graduate School of Information Science and Electrical Engineering, IMI, Faculty of Medical Science	whole (Priority Support)	Enhance cyber security education	1 Professor	Representative : RIIT
FY2019	RIIT, IMI, Medical Institute of Bioregulation, Research Institute for Applied Mechanics, Institute for Materials	whole	Promote interdisciplinary research based on pan-omics measurement and computational science approaches	2 Assistant Profs. (from FY 2019 to FY2023)	Representative : RIIT

	Chemistry and Engineering				
FY2022	IMI	departments	Establishment of "Division of Industrial and Mathematical Statistics"	1 Assistant Prof. (FY2022 ~ FY2026)	Applied 1 Prof. and 1 Assistant Prof.
FY2023	Graduate School and Faculty of Information Science and Electrical Engineering, IMI, Faculty of mathematics, Faculty of Economics	whole	Creation of a market design research and education center for the realization of comprehensive knowledge	1 Associate Prof. (FY2023 ~ FY2027)	Representative : Graduate School and Faculty of Information Science and Electrical Engineering
FY2024	Graduate School and Faculty of Information Science and Electrical Engineering, IMI, Faculty of mathematics	departments (Except for the portion for strengthening human resources functions)	Establishment of a research and education center for giant mathematical structure processing systems	1 Associate Prof. (FY2024 ~ FY2028)	Representative : Graduate School and Faculty of Information Science and Electrical Engineering

- "RIIT" means "Research Institute for Information Technology".
- In "Classification", "Whole" means Whole School Reform Progress, while "Department" means Reform of Ministries and Departments.
- The measures are assigned the following "Points" according to the position of the teacher. This is the same for both measures:
Professor: Professor, Associate Professor: 0.790, Assistant Professor: 0.583.
- The "Application Details" are the same as the measures, unless otherwise noted.

Kyushu University Fund "Project for Human Resource Development in Mathematics for Industry"

On May 14, 2021, IMI held a ceremony to commemorate the 10th anniversary of its establishment and announced the "IMI Manifesto 2021", which states that IMI, as a center for mathematics for industry in Japan, will continue to promote research in new mathematics together with industry, foster human resources with a high awareness of industry and mathematical ability, and create organic linkages between industry and mathematics, thereby contributing to the development of mathematics-for-industry. The IMI Manifesto 2021, which is the foundation for the development of mathematics-for-industry by promoting new mathematical research with industry, fostering human resources with a high awareness of industry and mathematical abilities, and creating organic linkages between industry and mathematics, has been announced both inside and outside Japan.

In line with this Manifesto, the "Project for Human Resource Development in Mathematics for Industry" was established within the Kyushu University Foundation. This project will contribute

to the development of various projects necessary to cultivate human resources with high mathematical ability and co-creation ability who are aware of the contribution to industry by pioneering new mathematics that creates technological innovation in industry and utilizing the knowledge of mathematics pioneered in industry through exchanges between industry and the university.

Collection Period: May, 2021~March, 2026

The “target amount” below refers to the amount for the above application period.

Target Amount: 12 million Yen

Amount of money raised: Corporate organizations: 100,000 yen per unit; Individuals: 10,000 yen per unit (multiple units permitted)

Other matters shall be in accordance with the operating policies of the Kyushu University Foundation.

The purpose of this fund is to be used for the following projects:

- Plan and organize Study Group Workshops (SGW) and other gatherings as a venue for pioneering new mathematics that will create technological innovations in industry and for fostering human resources who will apply the advanced mathematical knowledge they have pioneered in industry [target: 2 million yen].
- Develop long-term internships for doctoral students and acceptance of working doctors to cultivate students' problem-solving skills in industrial settings and plan and operate seminars and other gatherings necessary for matching so that companies will have more opportunities to utilize advanced mathematics personnel in their operations [target amount: 2 million yen].
- Invite researchers from industry to the university as seminar lecturers to teach graduate students the knowledge that will serve as the foundation for pioneering new mathematics that will create technological innovation in industry through lectures, seminars, etc., leading to the development of human resources [target amount: 1.5 million yen].
- Dispatch researchers from universities to industry as seminar lecturers to support the acquisition of advanced mathematical knowledge, leading to the development of human resources [target amount: 1.5 million yen].
- Promote exchanges between industry and universities, deepen mutual understanding, and plan and organize gatherings that will help develop new human resources in mathematics graduate schools [target amount: 2 million yen].

- Plan, organize, and financially support gatherings that will create opportunities for young researchers, especially graduate students, or female researchers, as new leaders in mass-for-industry [target amount: 3 million yen].
- The contents of the projects will be sequentially reviewed as the projects progress, and financial support will be actively considered for projects other than those mentioned above that will lead to the development of human resources to take charge of mathematics-for-industry.

Through the end of FY2022, the endowment amounts are as follows.

FY2021 1,651,000 yen **FY2022** 471,000 yen

4. Buildings

IMI has experienced the relocation of its organizational activities to the Ito Campus from the Hakozaki Campus of Kyushu University. This chapter will briefly summarize the history of the project, as well as the annexes associated with the project.

• Ito Campus Mathematical Sciences Research and Education Bldg.

In October 2009, the “Research and Education Building for Mathematical Sciences” (currently the “Information Technology Research and Development Center Building”) was completed on the Ito Campus, where the Graduate School of Mathematics and the Graduate School of Mathematics moved to. IMI was established in April 2011 and started its operation in the new building.

• Ito Campus West Building No.1

In October 2015, the Graduate School of Mathematics and IMI moved to the West Building No. 1 and began operating in this building. Most of the IMI faculty members have their offices on the 7th floor (the 6th floor is mainly occupied by the faculty of the Graduate School of Mathematics). The “Project Research Office” is located in Building E, where young researchers such as students and post-doctoral fellows who participate in projects funded by large research grants and administrative staff members are stationed.

• Australia Branch

In March 2015, IMI established an Australian branch office at La Trobe University (Melbourne, Australia). Full-time faculty members hired in Australia will be stationed there to serve as a hub for promoting projects such as joint research with research institutions in the Oceania region, student exchanges, and international internships. It will also oversee collaborative exchange activities with leading research institutions in Australia and New Zealand.

•Tokyo Branch

Kyushu University established the Kyushu University Tokyo Office and the Kyushu University Osaka Office as of April 1, 2014. These offices were established for the purpose of contributing to the advancement of Kyushu University's education and research and the promotion of industry-academia-government collaboration through the collection and dissemination of information, collaboration with businesses and other organizations, and exchange with alumni, etc. On April 1, 2023, the “Institute for Mass-for-Industry Research” was established in the same office. Tokyo Branch” was established in the same office on April 1, 2023.

Old address (until July 24, 2023)

Yurakucho Bldg. 6F 605-606, 10-1, Yurakucho 1-chome, Chiyoda-ku, Tokyo 100-0006, Japan

New address (from July 25, 2023)

8F, Yurakucho Denki Bldg. North Bldg. 810-811, 1-7-1 Yurakucho, Chiyoda-ku, Tokyo 100-0006, Japan

•Co-evolutionary Social Systems Innovation Facility

This facility was used in the activities of the “Regional Innovation Center for Sustainable Coevolution” under the COI Program of the Japan Science and Technology Agency, which began in FY2013 and ended in FY2021.

This project is led by Professor Yasuhide Fukumoto of IMI.

<https://coi.kyushu-u.ac.jp/en/topics/view/301>

The Center for Sustainable Co-Evolution and Regional Innovation initially developed its activities at the “Innovation Plaza for Industry-Academia-Government Collaboration” (Momochihama, Sagara-ku, Fukuoka City), but in March 2015, it moved to this facility on the Ito Campus.

In addition to housing research members from IMI, the facility was also used as a base for the activities of Kaname Matsue and Hoa Dinh Nguyen, tenure-track faculty members with I²CNER

(International Institute for Carbon-Neutral Energy Research, as of April 1, 2023, Associate Professor at IMI and I²CNER, respectively).

5. Joint Research Center Projects

In April 2013, IMI was recognized by the Minister of Education, Culture, Sports, Science and Technology (MEXT) as an “*Joint Research Center for Advanced and Fundamental Mathematics-for-Industry*” and is promoting the realization of its philosophy of “mathematics-for-industry”. As one of the core projects of the center, the center conducts joint research projects with an open call for proposals, and once a year (around November to January), it conducts an open call for research plans.

In addition, from FY2022, the center has established a “Call for Proposals at Any Time” and is always accepting applications for proposals that are worthy of support by the center, without limiting the period of the annual call for proposals.

5.1 Management

The IMI is managed by the “Steering Committee”, “Joint Usage/Collaborative Research Committee”, and “International Project Committee”. Each committee consists of internal members, internal members consisting of Kyushu University members other than IMI, and external members consisting of members from universities, research institutes, and companies outside Kyushu University.

Steering Committee Members (FY2023)

Committee Member	Official Title
(External committee members)	
Takanori Ide	AISIN CORPORATION
Motoko Kotani	TOHOKU UNIVERSITY
Koichi Shirozu	TOYOTA MOTOR CORPORATION
Jun Sekine	Graduate School of Engineering Science, OSAKA UNIVERSITY
Akira Takada	Faculty of Maths & Physical Sciences, University College London
Satoshi Taguchi	Graduate School of Informatics, Kyoto University
Hiroe Tsubaki	The Institute of Statistical Mathematics, Research Organization of Information and Systems

Junichi Nakagawa	Graduate School of Mathematical Sciences, The University of Tokyo NIPPON STEEL RESEARCH INSTITUTE CORPORATION
Hiraku Nishimori	Meiji Institute for Advanced Study of Mathematical Sciences
Shinji Hara	The University of Tokyo, Tokyo Institute of Technology
Kazuhisa Makino	Research Institute for Mathematical Sciences, Kyoto University
Mikiya Masuda	Osaka Metropolitan University
Shiho Moriai	Cybersecurity Research Institute, National Institute of Information and Communications Technology

(Internal committee members, Kyushu University)

Hidetaka Arimura	Graduate School of Medical Sciences, Kyushu University
Koji Okamura	Research Institute for Information Technology, Kyushu University
Takashi Okayasu	Graduate School of Bioresource and Bioenvironmental Sciences School of Agriculture, Kyushu University
Masato Tsujii	Faculty of Mathematics, Kyushu University

(Internal committee members, IMI)

Kenji Kajiwara	Institute of Mathematics for Industry (Director), Kyushu University
Osamu Saeki	Institute of Mathematics for Industry, Kyushu University
Koji Nuida	Institute of Mathematics for Industry, Kyushu University
Kei Hirose	Institute of Mathematics for Industry, Kyushu University
Yasuhide Fukumoto	Institute of Mathematics for Industry, Kyushu University
Katsuki Fujisawa	Institute of Mathematics for Industry, Kyushu University
Yoshihiro Mizoguchi	Institute of Mathematics for Industry, Kyushu University

List of Joint Research Committee (FY2023)

Committee Member	Official Title
(External committee members)	
Emiko Ishiwata	Department of Applied Mathematics, Faculty of Science Division I, Tokyo University of Science
Akira Ohata	MathWorks Inc.
Takayuki Osogami	IBM Japan Ltd.
Nobuaki Obata	Center for Data-driven Science and Artificial Intelligence, Tohoku University

Akira Nakagawa	Fujitsu Limited
Isamu Hasegawa	SQUARE ENIX HOLDINGS CO., LTD.
Masahiro Yamamoto	Graduate School of Mathematical Sciences, The University of Tokyo
Masaya Yasuda	College of Science, Rikkyo University

(Internal committee members, Kyushu University)

Fumio Hiroshima	Faculty of Mathematics, Kyushu University
Koichi Matsumoto	Graduate School of Economics, Kyushu University
Yukiko Yamauchi	Graduate School and Faculty of Information Science and Electrical Engineering, Kyushu University

(Internal committee members, IMI)

Hiroyuki Ochiai	Institute of Mathematics for Industry, Kyushu University
Shizuo Kaji	Institute of Mathematics for Industry, Kyushu University
Naoyuki Kamiyama	Institute of Mathematics for Industry, Kyushu University
Tomoyuki Shirai	Institute of Mathematics for Industry (Deputy Director), Kyushu University
Ryoko Tomiyasu	Institute of Mathematics for Industry, Kyushu University

International Project Committee Roster (FY2023)

Committee Member	Official Title
(External committee members)	
Ken Anjo	Technical Advisor, OLM Digital, Inc.
Takayuki Osogami	Senior Technical Staff Member, IBM Research – Tokyo
Philip Broadbridge	Emeritus Professor, Mathematics & Statistics, La Trobe University
Kim Chuan Toh	Professor, Institute of Operations Research and Analytics, National University of Singapore
Konrad Polthier	Professor, Head of Mathematical Geometry Processing, Institute of Mathematics, Freie Universität Berlin
Wil Schilders	Full Professor, Chair, Scientific Computing in the Industry in the Department of Mathematics and Computer Science, Eindhoven University of Technology

(Internal committee members, Kyushu University)

Fumio Hiroshima Professor, Faculty of Mathematics, Kyushu University

(Internal committee members, IMI)

Hiroyuki Ochiai Professor, Institute of Mathematics for Industry, Kyushu University

5.2 Activities

The core project of this center is the solicitation and implementation of “Collaborative Research”. The research projects that are open to the public can be broadly classified into the following five categories.

1. Project research
Each year, IMI selects one or two areas of particular focus and invites research proposals from two representatives, one from IMI faculty and one from an outside researcher.
2. International Project Research
This category is an open call for research with the requirement that the Principal Investigator be affiliated with an overseas institution.
3. Women Researchers Active in Supporting Research
This category is an open call for research with the requirement that the Principal Investigator be a female researcher. The research categories described below are not specified.
4. Young Scientist/Student Research
This category is open to young researchers and graduate students who have been working as Principal Investigators for less than eight years (excluding the period of maternity leave and childcare leave). After the program is adopted, IMI will introduce appropriate researchers from industry as participants or advisors.
5. General research
This category is an open call for research with no particular restrictions on research fields or attributes of the principal investigator other than those listed above.

There are six categories for each species, differentiated according to size and type of implementation.

- Workshop (I)

- Workshop (I): Online-style
Research themes are eligible if they are recognized as designated themes and can be developed with industry-academia collaboration in mind.
- Workshop (II)
- Workshop (II): Online-style
Research themes that are more embryonic in nature than Workshop (I) are eligible for this program.
- Short-term collaborative research
This is a substantial joint research project with a small group of people. There are no restrictions on the duration of the research, provided that it is completed by the end of the fiscal year. A wide variety of research themes are eligible for support, ranging from budding research in mathematics that anticipates future industrial applications to research that directly contributes to solving industrial problems. The emphasis is on problems that have a certain degree of universality, which can be tackled in cooperation with researchers from multiple companies and research institutions, rather than narrow problems that are directly related to the intellectual property of individual companies.
- Short-term researchers
The IMI Short-term Researchers will stay at IMI for one to two weeks and conduct independent or collaborative research in close contact with IMI and other faculty members at Kyushu University. The research topics will include budding issues that are expected to lead to short-term joint research or research meetings, or issues that have arisen in the field of research and development in companies, etc., for which intensive joint research will lead to solutions or clues, and which will become the seeds for new mathematics-for-industry or industry-academia collaboration in the near future.

After the completion of the research, the participants are required to submit an A4 paper of about 2 pages for research meetings and about 3 pages for other meetings. As for the Workshop (I), the proceedings will be published online as “MI Lecture Notes” by IMI, or as a volume of “Mathematics for Industry”, a series of books published by Springer over a period of about six months to a year, with the proceedings in peer-reviewed English as a part of the book as the responsible editor. The proceedings will be published in one of two ways. Past records are available at

<https://joint.imi.kyushu-u.ac.jp/en/>

See Chapter 6 for data summarizing the number of cases.

The list of joint research projects selected for FY2022 is shown in Table 5.1.

Classification

A: Project Research B: International Project Research C: Research to Support the Advancement of Female Researchers

D: Young Scientist/Student Research E: General Research F: Proposals at Any time Event

1:Workshop (I) 2:Workshop (I), Online-Style 3:Workshop (II)

4:Workshop (II), Online-Style 5:Short-term collaborative research 6:Short-term researchers

The organization, department, and official titles of the Representatives are as of the date of the meeting.

Table 5.1 List of FY2022 Joint Research Projects Adopted and Implemented

Classification	Representative	Affiliation・Official Title	Research Title	Date	Participants
A-5	Yusuke Aikawa	Information Technology R&D Center, Mitsubishi Electric Corporation/Researcher	Mathematics of Next-Generation Cryptography for Secure Utilization of Quantum Information	2022-08-01 ~ 2022-08-05	318 (Hybrid)
A-6	Kazumasa Shinagawa	Ibaraki University/Assistant Professor	On Minimal Construction of Private Simultaneous Messages Protocols	2022-09-05 ~ 2022-09-16	2 (In-Person)
B-1	Christopher Lenard	La Trobe University/Head of Department of Mathematical and Physical Sciences	Statistics and Mathematical Modelling in Combination	2022-11-16 ~ 2022-11-18	50 (Hybrid)
C-1	Naoko Nakayama	Mamezou Co., Ltd. Strategic Digital Business Unit/Chief consultant	Construction of mathematical basis for realizing data rating service	2022-09-21 ~ 2022-09-22	54 (In-Person)
C-5	Yujie Gu	Faculty of Information Science and Electrical Engineering, Kyushu University/Assistant Professor	Combinatorial Approach to Machine Learning	2022-09-20 ~ 2022-09-22	73 (Hybrid)
D-5	Yuki Ishihara	Tokyo University of Science, Faculty of Science Division I, Department of Applied Mathematics/Assistant Professor	Construction of efficient algorithms for quantifier elimination and their application to solving industrial problems	2022-10-31 ~ 2022-11-04	55 (Hybrid)

D-5	Yusuke Imoto	Kyoto University/Assistant professor	Theoretical approach of numerical differentiation with high accuracy and speed based on hyper-dual numbers	2022-08-08 ~ 2022-08-10	39 (Hybrid)
D-5	Shohei Satake	Meiji University/Assistant Professor	Toward a new method for constructing expander graphs and their applications	2022-08-22 ~ 2022-08-26	105 (Hybrid)
D-5	Muhammad Nurjati Hidayat	Department of Civil Engineering, Faculty of Engineering/PhD Student	Building EWS using Edge AI and IoT	2022-10-15 ~ 2022-10-15	127 (Hybrid)
D-5	Yoshiki Jikumaru	Kyushu University, Institute Mathematics for Industry/Postdoc	Discrete membrane O surface theory and graphic statics for a development of architectural surface design method	2022-05-12, 2022-05-26, 2022-06-09, 2022-06-23, 2022-07-07	22 (Online)
E-1	Shigeki Matsutani	Graduate School of Natural Science & Technology, Kanazawa University/Professor	Geometry and Algebra in Material Science III	2022-09-08 ~ 2022-09-10	111 (Hybrid)
E-1	Satoshi Tanda	Hokkaido University, Department of Engineering/Professor	Theory and experiment for time, quantum measurement and semiclassical approximation-interface between classical and quantum theory-	2022-07-21 ~ 2022-07-23	29 (In-Person)
E-3	Hroki Masuda	Faculty of Mathematics, Kyushu University/Professor	Statistical science in data science	2022-11-26 ~ 2022-11-26	55 (Hybrid)
E-3	Norihiro Nakashima	Nagoya Institute of Technology, Faculty of Engineering/Associate professor	Relationship between error-correcting codes and hyperplane arrangements and their applications	2022-06-16 ~ 2022-06-16	32 (In-Person)
E-3	Fumitaka Hoshino	University of Nagasaki, Faculty of Information Security/Professor	Advances in Sophisticated Cryptography and Mathematical Techniques	2022-11-07 ~ 2022-11-09	159 (Hybrid)

E-5	Yasuyoshi Yonezawa	Quantinuum K.K./Quantum Software Outreach Officer	Exploring Mathematical Challenges in Quantum Computing and Quantum Human Resource Development	2022-08-22 ~ 2022-08-26	69 (Hybrid)
E-5	Kazunori Kuwana	Department of Global Fire Science and Technology/Professor	Mathematics of unstable combustion: extinction and flame oscillation	2022-11-04, 2023-03-06	21 (Hybrid)
E-5	Isao Ishikawa	Center for Data Science, Ehime University/Associate professor	Boundedness of Koopman operators on Besov spaces and its applications	2022-05-23 ~ 2022-05-27	15 (In-Person)
E-5	Hiroyuki Inou	Graduate School of Science, Kyoto University/Associate professor	Interactive cognition of higher dimension with VR 2	2022-08-29 ~ 2022-09-02	44 (Hybrid)
E-5	Hemanta Hazarika	Kyushu University, Graduate School of Engineering/Professor	Study on Field Application of Slope Disaster Countermeasures with Reduced Environmental Impact	2022-07-01, 2023-01-26 ~ 2023-01-27, 2023-02-23 ~ 2023-02-25	73 (Hybrid)
E-5	Hiroto Kuroda	Department of Mathematics, Faculty of Science, Hokkaido University/Associate Professor	Fundamentals of Mathematical Science for Industrial Applications of Discrete Geometric Mechanics	2023-01-21 ~ 2023-01-22	41 (Hybrid)
E-6	Hidetoshi Matsui	Faculty of Data Science, Shiga University/Associate Professor	Statistical modeling for high-dimensional data and its application to E-agriculture	2022-09-12 ~ 2022-09-16	2 (In-Person)
E-6	Kazuo Matsuura	Graduate School of Science and Engineering, Ehime University/Associate Professor	Development of a new stability theory for general vortices in transitional and turbulent flows based on hierarchical vortex clustering	2023-01-17 ~ 2023-01-18	2 (In-Person)
F-4	Yutaka Jitsumatsu	Department of Information and Communications Engineering/Associate Professor	Mathematics for Innovation in Telecommunications Technology	2022-09-15 ~ 2022-09-16	71 (Hybrid)

F-4	Takahi NAKAZAWA	MMDS, Osaka university/Associate Professor	Between Mathematics and Industry	2022/9/20	53 (Online)
F-4	Toshiaki Maeno	Faculty of Science and Technology, Meijo University/Professor	2022 workshop on interaction between CRyptography, Information Security and MATHeMatics (CRISMATH 2022)	2022-12- 20 ~ 2022-12- 21	65 (Hybrid)

Starting in FY2022, the “Call for Proposals at Any Time” program will begin accepting monthly applications for small-scale joint research plans.

6. Data on Research Activities of the Institute's Members

This chapter summarizes data on research activities by IMI members (including some former members) from the establishment of IMI to FY2022 and discusses research trends based on these data.

6.1 Throughout: Data Collection

Various data since the establishment of IMI are being compiled at this time. The administrative structure has undergone a major change since mid-2015, and the data were allocated to the Administrative Division of the Faculty of Science and other faculties. Prior to that, the “Administrative Office of the Faculty of Comparative Studies for Society and Culture” had managed the data, but much of the data was lost during the handover. Therefore, it should be noted that some of the data only remain from FY2016, and the report is based on data from later years.

Furthermore, the “number of conference presentations”, which is large in number, has changed significantly between FY2021 and before and FY2022, as discussed below. This difference may be related to “differences in information collection sources”. To describe the basis for this difference, we must refer to the way in which data was collected in the process of writing this report.

This report was initially compiled and written as a report on performance through FY2021. Writing then stalled, and writing resumed in July 2023, after the “Division of Strategic Liaison” was newly established in FY2023 and a faculty member engaged in administration and management was assigned to the division. In the meantime, the information recorded in Q-RADeRS* (prior to FY2021), the source for collecting information on research activities, was substantially changed.

(* Kyushu University Researcher’s Activity Development & Reports system.)

In fact, information from Q-RADeRS prior to FY2021 was obtained in “October 2022” and FY2022 in “July 2023”. The relevant items are “conference presentations” and “published papers”.

During this period, information for FY2021 and earlier was modified and various information was altered.

The data for “Publications” were able to reflect the data obtained in FY2022. On the other hand, “Conference presentations” were in a wide variety of formats, including academic conferences, research meetings, and seminars, and it took a great deal of effort to distinguish between them, and some presentation formats could not be determined. On the other hand, the information added after October 2022 includes a wide range of information on faculty members who were appointed in FY2022, as well as information on faculty members who had previously been appointed.

Furthermore, since the addition of information to Q-RADeRS is left to “individual faculty members' descriptions”, we concluded that it would be impractical to control and distinguish between them.

Therefore, it should be noted that the data on conference presentations are incorporated from the data obtained in “October 2022” for FY2021 and before, and from the data obtained in “July 2023” for FY2022.

6.2 Number of Seminar and Intensive Lectures

Figure 6.1 shows the transition of seminars related to mathematics and applied mathematics, and Figure 6.2 shows the transition of intensive lectures.

Figure 6.1 Number of seminars held

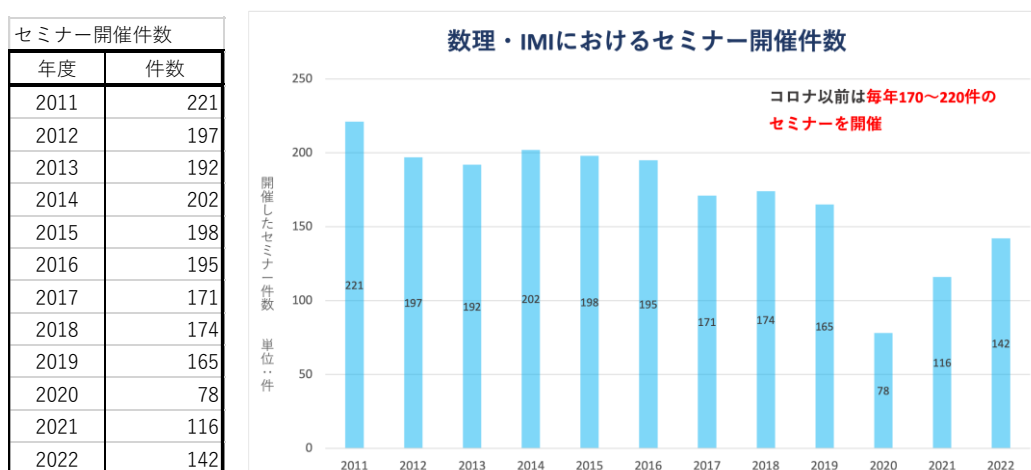
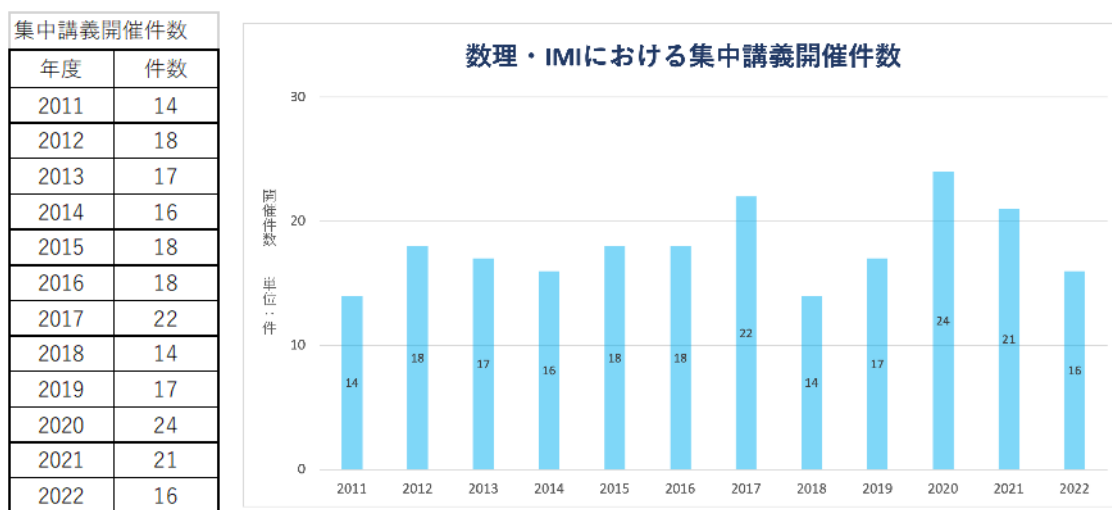


Figure 6.2 Number of intensive lectures held



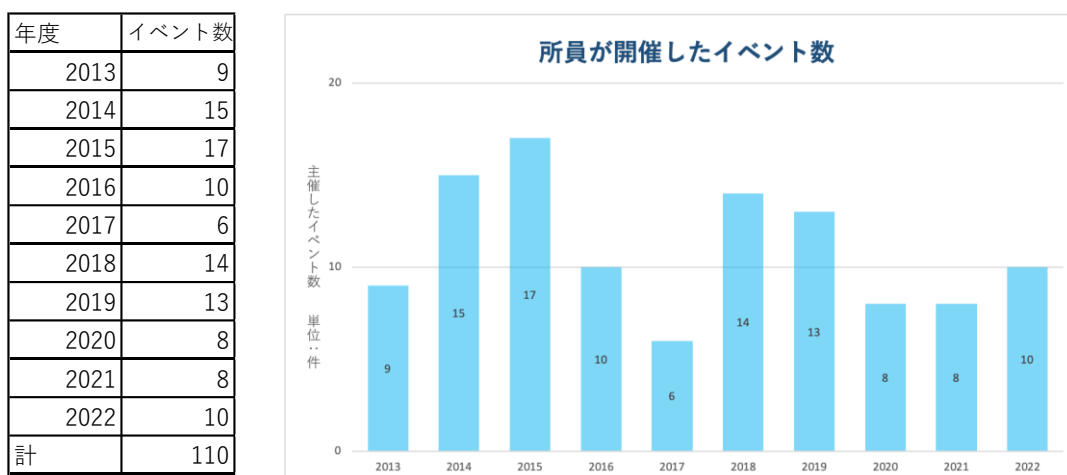
Seminars and intensive lectures are not closed at IMI but are a mixture of those organized by faculty members of the Graduate School of Mathematics. Since no clear distinction exists between IMI and the Institute of Mathematical Sciences seminars as well as intensive lectures, the number of them in this report is taken to mean the “sum of those events held at the Institute of Mathematical Sciences and IMI”.

Prior to FY2019, on average, about 200 seminars and 20 intensive lectures were held. In FY2020, the number of them declined sharply due to behavioral restrictions triggered by the novel coronavirus. On the other hand, the number of intensive lectures has increased. This is thought to be due to an increase in the number of online-style lectures. In FY2022, although the number of seminars has not returned to the pre-restriction level, the number of seminars held, including online and hybrid seminars, is expected to be on a recovery trend and is expected to recover to the pre-restriction level around FY2024.

6.3 Organized Events

Figure 6.3 shows a transition of events organized by IMI staff.

Figure 6.3 Number of events conducted by IMI



This includes SGW (Study Group Workshop. See Section 6.17) and FMfl (Forum “Math-for-Industry”. See Section 8.4), which will be mentioned later.

As far as the number of events is concerned, the number of events is highly variable from year to year.

As an overall trend, workshops, SGW, and FMfl in the field related to “quantum resistant cryptography” are held almost every year.

The number of events has been decreasing due to the action restriction in FY2020, but there were some years before that when the number of events was below the number at the time of the restriction, so the correlation between the action restriction due to the new coronavirus and the number of events is not considered to be significant. The establishment of an Australian branch of IMI at La Trobe University in Australia at the end of FY2014 led to an increase in the number of research meetings jointly hosted by IMI and La Trobe University in FY2015. In addition, several events related to the Joint Research Center were also held in the same year. The sharp increase in the number of events recorded in FY 2018 reflects the fact that AIMaP (Advanced Innovation powered by Mathematics Platform, see Chapter 11) began in FY2017 with IMI as the base institution, and AIMaP-supported research meetings and events were held. Since then, the number of events has remained stable: around 10, even after the AIMaP ended.

6.4 IMI Colloquium

The IMI Colloquium and the number of participants are shown in Table 6.4 and Figure 6.5. A breakdown of participants has also been included since 2019.

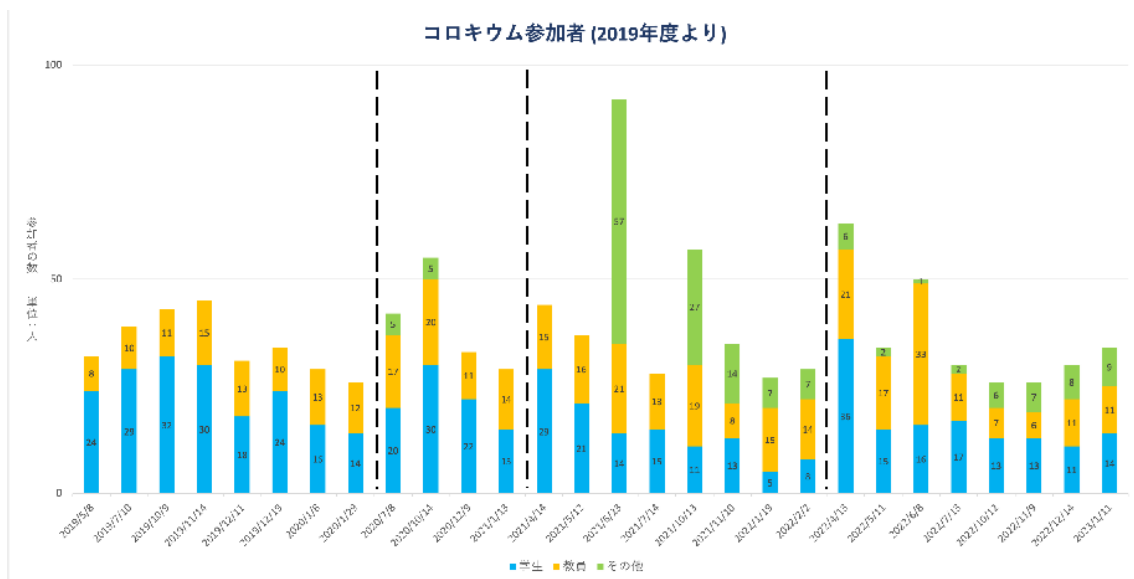
Table 6.4 IMI Colloquiums Held.

The order of the categories is "faculty," "students," and "others."

Post-doctoral fellows are included in the "faculty" category.

		2019					2021		
		教員	学生	その他					
2019	2019/5/8	8	24		2021	2021/4/14	15	29	
	2019/7/10	10	29			2021/5/12	16	21	
	2019/10/9	11	32			2021/6/23	21	14	57
	2019/11/14	15	30			2021/7/14	13	15	
	2019/12/11	13	18			2021/10/13	19	11	27
	2019/12/19	10	24			2021/11/10	8	13	14
	2020/1/8	13	16			2022/1/19	15	5	7
	2020/1/29	12	14			2022/2/2	14	8	7
	2020	2020/7/8	17	20		5	2022	2022/4/13	21
2020/10/14		20	30	5	2022/5/11	17		15	2
2020/12/9		11	22		2022/6/8	33		16	1
2021/1/13		14	15		2022/7/13	11		17	2
					2022/10/12	7		13	6
				2022/11/9	6	13		7	
				2022/12/14	11	11		8	
				2023/1/11	11	14		9	

Figure 6.5 Graphical representation of Table 6.4



グラフにおいて、黒の破線は年度の区切りを表している。

Since the establishment of IMI, the IMI, the Graduate School of Mathematics, and the Graduate School of Mathematics have invited lecturers from inside and outside the university, including from industry, to conduct IMI Colloquiums. The backgrounds of the lecturers are diverse. As an example, the FY2022 event is shown in Table 6.6 below.

Table 6.6 Details of the IMI Colloquium for 2022

Date	Lecturer	Title
Apr. 13	Tsuyoshi Okamoto (Faculty of Arts and Science, Kyushu University)	Let's discover the connection between brain and mathematics.
May. 11	Isao Takabe (Faculty of Data, Science, Rissho University)	Research examples using official statistics micro data
Jun. 8	Shigeo Mitsunari (Cybozu Labs, Inc.)	Cryptography Implementation and Mathematics
Jul. 13	Kazuhiro Minami (The Institute of Statistical Mathematics)	Optimization of cell suppression process on tabular data and algorithmic matching attack
Oct. 12	Takuji Hiraoka (Fixstars Amplify Corporation)	Building a Combinatorial Optimization Cloud and Challenges
Nov. 9	Makoto Tukamoto (Fusic Co., Ltd.)	Mathematical modeling and system development for the next phase
Dec. 14	Taisuke Otsuru and Shinichi Tokunaga (Itoshima City, Economic Development Department-Gakkentoshi Development Section)	Solving local issues by mathematics approach indicated by the cases in cooperation between Itoshima City and IMI
Jan. 11 (2023)	Mitsugu Mera (Technical Research Center, Mazda Motor Corporation)	Activities for Utilizing Mathematics in Automotive Technology Research and Future Plans

The general trend each year is that the number of participants is high at the beginning of the year and declines as the year progresses into the second half of the year. This trend is common among both faculty and students. Since most research meetings and academic conferences are held in August, September, February, and March, when classes are out of session, they are not held in those months in principle. On the other hand, while there are many participants in July, the month before that, there is a marked decrease in the number of participants in January. The tendency is simply “lower awareness of attendance in the second half of the year,” but identifying the causes and proposing remedial measures are issues to be addressed in the future.

On the other hand, the IMI Colloquium is assigned as an “MMA Practical Lecture” for the “MMA Course of the Graduate School of Mathematics,” and students are required to attend and submit reports to obtain credits. Therefore, the colloquium has become a half-obligation for MMA course students, contributing to attracting a certain number of attendees.

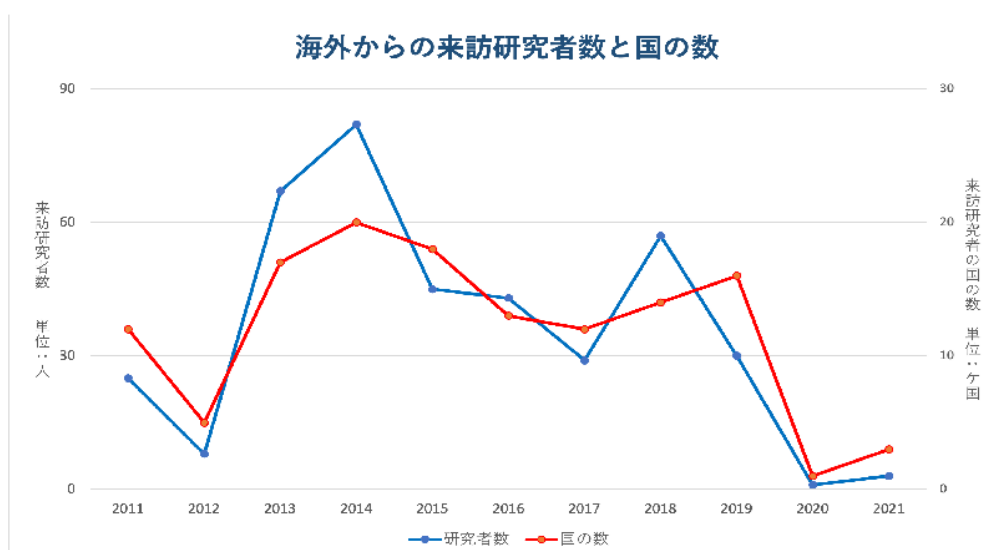
After FY2020, the face-to-face sessions were forced to be canceled due to action restrictions, but the IMI Colloquium was launched in an online format instead, contributing to the recovery of implementation over the second half of the fiscal year. Since then, the online hybrid format has been flexibly adopted, and the number of implementations has recovered to the pre-behavioral restriction level. On the other hand, the number of participants remained on a downward trend as the second half of the fiscal year progressed.

6.5 Number of visiting researchers from abroad

Figure 6.7 below shows information on researchers affiliated with foreign countries who visited IMI. However, the “country” of the researcher is not unified because the information collected in the Kyushu University database “Q-RADeRS” is “nationality,” and each data entrant has a different opinion on the “country of affiliation at the time of the visit” and the “country of birth of the researcher. Therefore, the only reliable information on “country” is available for FY2022 (after re-verification and unification of data by “country of affiliation”), and data by country for FY2021 and earlier should be used only as reference.

Figure 6.7 Number of Visitors from Abroad and Countries (see also note in text)

海外からの来訪研究者数と国数													
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	計
研究者数	25	7	67	82	45	43	29	57	30	1	3	36	425
国の数	14	5	23	21	20	16	14	18	17	1	3	14	



The number of visitors has increased rapidly since FY 2013, averaging 50 visitors/year. The number of visitors has been hit by the impact of the new coronavirus-derived behavioral

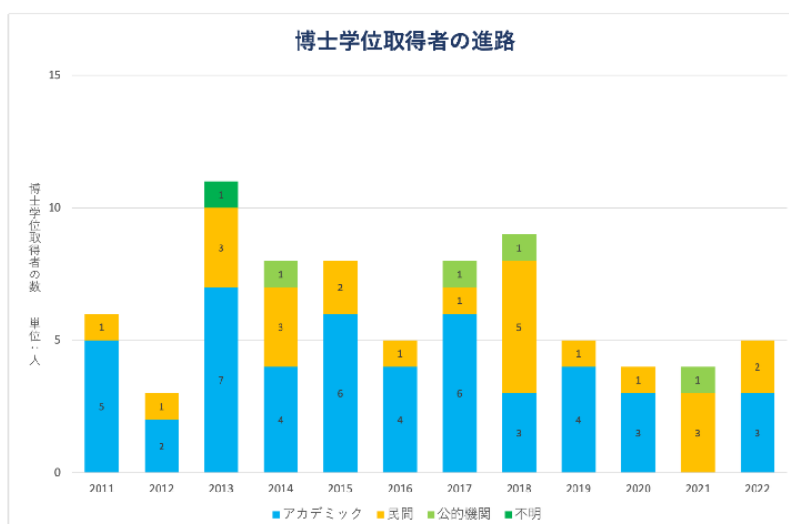
restrictions, and there have been almost no visitors since FY2020. We expect a recovery from FY2023, when behavioral restrictions have been eased nationally and globally.

6.6 Career paths for doctoral degree holders

Figure 6.8 shows the career paths of "Ph.D. students" supervised by IMI faculty members.

Figure 6.8 Career paths of doctoral degree holders

博士学位取得者の進路												
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
民間	1	1	3	3	2	1	1	5	1	1	3	2
アカデミック	5	2	7	4	6	4	6	3	4	3	0	3
公的機関	0	0	0	1	0	0	1	1	0	0	1	0
不明	0	0	1	0	0	0	0	0	0	0	0	0
計	6	3	11	8	8	5	8	9	5	4	4	5



IMI has been actively conducting joint research with private companies as well as internships for students, and since FY2013, these efforts have borne fruit, producing a steady stream of personnel into the private sector. In line with this, we do not see a trend of a relative decline in the number of students going into academia. Both private-sector and academic career paths have been declining since shortly before the outbreak of the new coronavirus. However, these figures are based only on doctoral degree recipients "supervised by IMI faculty" and do not take into account students supervised by members of the Faculty of Mathematics. Therefore, the increase or decrease in the number of students who obtained the degree is partly due to the difference in the affiliation of the supervising faculty members.

6.7 Status of Contracts for Funded and Joint Research

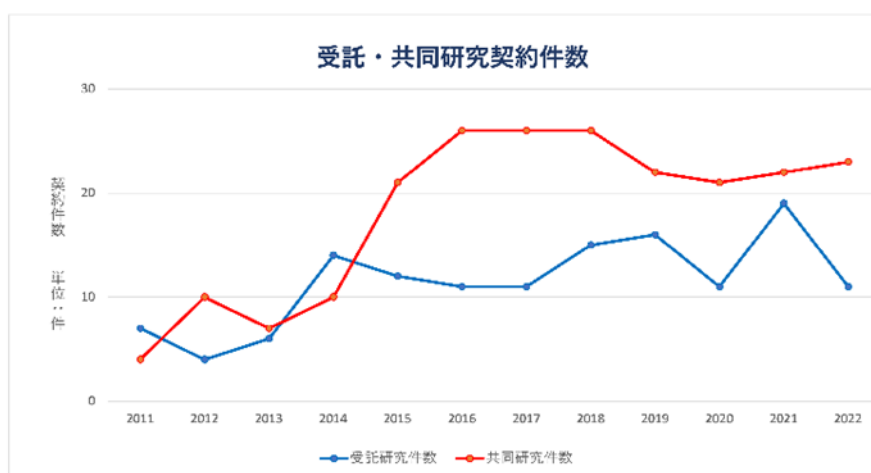
Figure 6.9 summarizes the trends in contracted and joint research agreements obtained by IMI faculty members.

Figure 6.9 Number and Total Amount of Contracts for Funded and Joint Research

受託・共同研究契約状況（金額の単位は「円」）

研究種別等	2011		2012		2013		2014		2015		2016	
	件数	金額	件数	金額	件数	金額	件数	金額	件数	金額	件数	金額
受託研究	7	35,700,000	4	25,713,700	6	33,480,500	14	74,292,500	12	98,325,000	11	78,791,000
共同研究	4	4,700,000	10	14,691,000	7	17,264,000	10	23,407,000	21	50,296,000	26	59,688,194

2017		2018		2019		2020		2021		2022	
件数	金額	件数	金額	件数	金額	件数	金額	件数	金額	件数	金額
11	78,948,790	15	81,178,857	16	13,112,659	11	333,935,329	19	113,165,929	11	52,897,078
26	47,913,768	26	58,048,720	22	42,687,760	21	52,826,000	22	68,464,060	23	66,572,024



“Funded research” includes large-scale research funds (such as CREST and the Future Society Creation Project) publicly solicited by JST (Japan Science and Technology Agency mentioned in Section 3.2). “Joint research” includes joint research contracts with private companies.

The amount of “funded research” depends on the timing of the relevant public offering, and the amount of money awarded varies greatly depending on the project. For example, in FY 2019, 16 projects were awarded about 13 million yen, and in FY 2020, the number of contracts decreased to 11, but the amount awarded increased 30-fold to more than 300 million yen. The majority of this increase is attributable to the “Coevolutionary Research for Sustainable Communities” project and the “JST-Mirai program”. The existence of these projects has a significant impact on acquisition funding.

From FY2014 to FY2018, more than a dozen contracts have been awarded, with a stable amount of around 80 million yen.

The number of “joint research” contracts has steadily increased since IMI's establishment and has sustained around 20 contracts since FY2015 (including continuing research). The total amount of research expenses depends on the progress of the research but has generally remained around 50 million yen. 68 million yen was recorded in FY2021 and is on the increase.

6.8 Grant-in-Aid for Scientific Research

The trends of science and technology research funds (Grant-in-Aid for Scientific Research, KAKENHI) obtained by IMI faculty members are summarized in Figures 6.10 (number of cases) and 6.11 (amount).

Figure 6.10 Number of Grants-in-Aid for Scientific Research Obtained by IMI Faculty

科学研究費採択状況(件数)												
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
基礎研究 (S)	0	0	0	0	0	0	1	1	1	1	1	0
基礎研究 (A)	1	1	1	1	1	1	2	1	1	1	1	1
基礎研究 (B)	6	6	5	4	4	7	7	8	8	5	6	3
基礎研究 (C)	4	2	2	5	7	8	6	6	6	8	10	11
若手研究	0	0	0	0	0	0	0	1	5	6	8	6
若手研究 (A)	1	1	0	0	0	0	0	0	0	0	0	0
若手研究 (B)	5	7	9	8	7	4	4	4	1	0	0	0
挑戦的研究	7	5	5	6	6	6	5	3	1	2	2	3
新学領域研究	0	1	1	1	1	0	0	2	3	2	2	1
研究活動スナート支援	0	0	0	0	0	1	1	0	0	0	2	3
国際共同研究加速基金(国際共同研究強化(A))	0	0	0	0	0	0	0	0	1	0	0	0
学術変革領域研究(A)	0	0	0	0	0	0	0	0	0	0	0	1
計	24	23	23	25	26	27	26	26	27	25	32	29

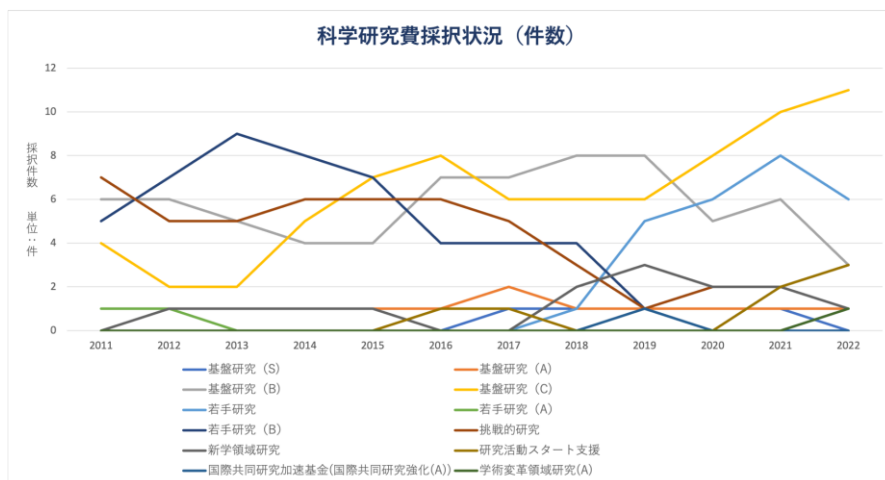
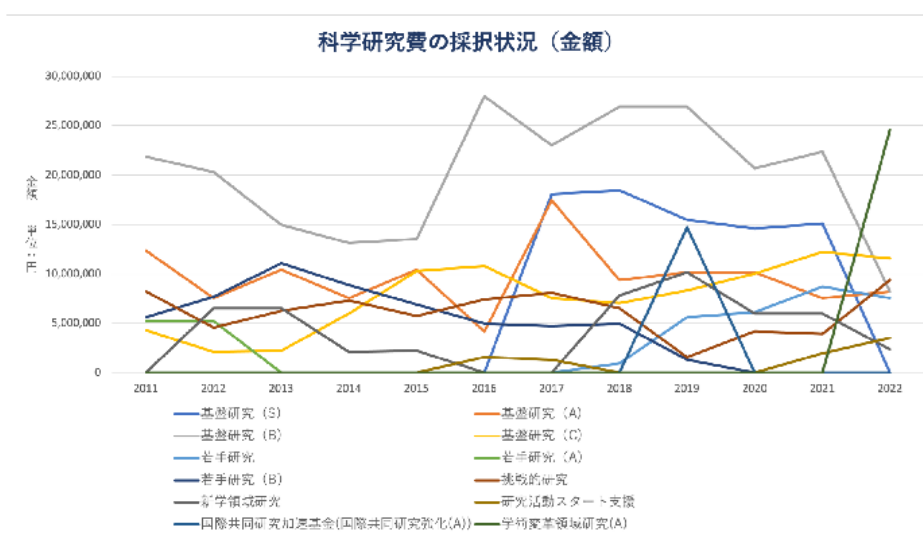


Fig. 6.11 Amount of Grants-in-Aid for Scientific Research Obtained by IMI Faculty (Unit: Yen)

科学研究費採択状況 (金額)												
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
基礎研究 (S)	0	0	0	0	0	0	18,070,000	18,460,000	15,470,000	14,560,000	15,080,000	0
基礎研究 (A)	12,350,000	7,540,000	10,400,000	7,540,000	10,400,000	4,160,000	17,420,000	9,360,000	10,140,000	10,140,000	7,540,000	8,190,000
基礎研究 (B)	21,840,000	20,280,000	14,950,000	13,130,000	13,520,000	27,950,000	23,010,000	26,910,000	26,910,000	20,670,000	22,360,000	8,190,000
基礎研究 (C)	4,290,000	2,080,000	2,210,000	5,980,000	10,270,000	10,790,000	7,540,000	7,020,000	8,320,000	10,010,000	12,220,000	11,570,000
若手研究	0	0	0	0	0	0	0	910,000	5,590,000	6,110,000	8,710,000	7,540,000
若手研究 (A)	5,200,000	5,200,000	0	0	0	0	0	0	0	0	0	0
若手研究 (B)	5,590,000	7,670,000	11,050,000	8,840,000	6,890,000	4,940,000	4,680,000	4,940,000	1,300,000	0	0	0
挑戦的研究	8,190,000	4,550,000	6,240,000	7,280,000	5,720,000	7,410,000	8,060,000	6,500,000	1,560,000	4,160,000	3,900,000	9,360,000
新学領域研究	0	6,500,000	6,500,000	2,080,000	2,210,000	0	0	7,800,000	10,140,000	5,980,000	5,980,000	2,340,000
研究活動スタート支援	0	0	0	0	0	1,560,000	1,300,000	0	0	0	1,950,000	3,510,000
国際共同研究加算基金(国際共同研究強化(A))	0	0	0	0	0	0	0	0	14,690,000	0	0	0
学術変革領域研究(A)	0	0	0	0	0	0	0	0	0	0	0	24,570,000
合計	57,460,000	53,820,000	51,350,000	44,850,000	49,010,000	56,810,000	80,080,000	81,900,000	94,120,000	71,630,000	77,740,000	75,270,000



While there are not a small number of grants awarded throughout, the total amount of research awarded (although not as much as for funded research) is largely dependent on the type of research obtained.

The most notable difference is before FY2016 and after FY2017. The former has remained below 60 million yen in total, while the latter has remained above 70-80 million yen. Although there are some factors such as the transition of the “Grants-in-Aid for Scientific Research (B)” category, the most significant factor that causes such a difference is the adoption of the “Grants-in-Aid for Scientific Research (S)” category. The difference in the total amount of research is a direct result of this.

On the other hand, the total amount of research funds, which had exceeded 80 million yen until FY2019, has dropped to around 70 million yen since FY2020. A major factor in this difference is the mechanism of the “Fund for the Promotion of Joint International Research”. Since the funds are provided in a lump sum in the first year, the actual amount used is equally distributed from the amount in 2019, the year of acquisition. The actual amount acquired in each year is expected to be close to the average of the previous and following years.

The impact on the total amount of research funds when large research funds such as Grants-in-Aid for Scientific Research (S) are eliminated after FY2022 will be enormous. This impact will not be fully covered by a few cases of “Grants-in-Aid for Scientific Research (B) and (C)”, small-scale funds compared with (S), but the total amount of these is not small either. In addition, young researchers' research funds such as “Early-Career Scientists (A) and (B)” were centralized into the “Early-Career Scientists” category from FY2018. As a result, the “Early-Career Scientists (A) and (B)” programs themselves have been eliminated in order from those with the earliest continuation deadlines, and in FY2020 they were reduced to zero, but the “Early-Career Scientists” program as a whole has shown a significant increase since then. In any case, these data suggest that increases and decreases in research funds, which are not so large per case, cannot be ignored.

In the case of FY2022, there was no significant decrease in the total amount because “Grant-in-Aid for Transformative Research Areas (A)” was obtained at the same time that “Grants-in-Aid for Scientific Research (S)” expired. On the other hand, in order to sustain and strengthen IMI's overall research funding (and associated operating expenses), it is necessary to obtain not only large-scale research funds but also more research funds that can be applied for at the individual level by both young and senior researchers.

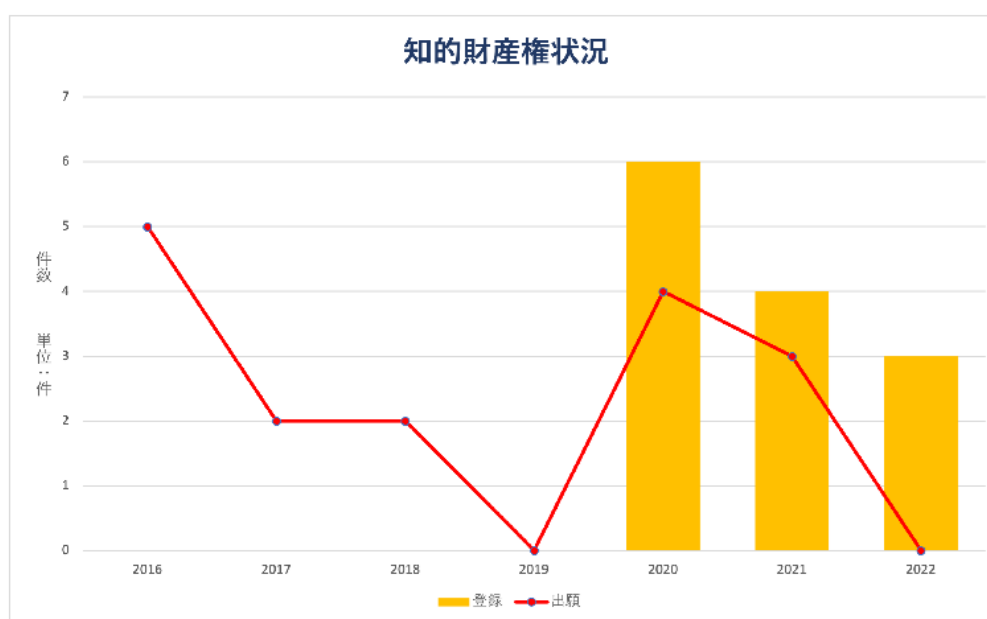
Note: As shown in the example of “Early-Career Scientists”, the classification of research expenses may change depending on the system of the funding source, such as the Japan Society for the Promotion of Science (JSPS). Furthermore, in some cases, the total amount is provided in a lump sum in the first year, instead of the amount provided in each fiscal year. The latter applies to the “Fund for the Promotion of Joint International Research”. In order to extract more accurate information, attention should be paid to these differences when compiling, editing, and viewing the data.

6.9 Acquisition of Intellectual Property Rights

Figure 6.12 shows the intellectual property applied for and registered by IMI faculty members.

Figure 6.12: Intellectual Property Applications and Registrations by IMI Faculty

知的財産権（出願・登録）状況								(件)
	2016	2017	2018	2019	2020	2021	2022	合計
出願	5	2	2	0	4	3	0	16
登録	0	0	0	0	6	4	3	10



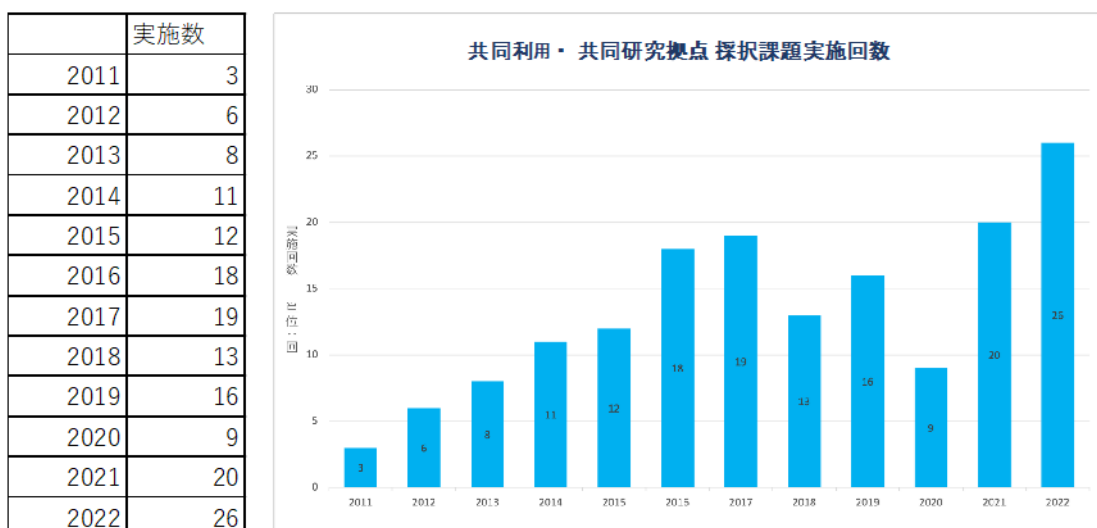
We first note that due to inadequate data management throughout Kyushu University, records have only been available since FY2016. Although the number of applications for patents is not large in itself in any of these cases, there are regular applications for patents. Unfortunately, none were realized to registration until FY2019, but the number of registrations has increased rapidly since FY2020.

This is due to the fact that it takes a long time from the filing of a patent application to the actual registration. In fact, all of the registrations that increased sharply in FY2020 were filed in FY2016; patents registered in FY2021 also include those filed in FY2017. Some of the applications filed in FY2020, such as those for electricity demand forecasting and human flow assessment, were registered within one year, but the acquisition of patents and other intellectual property should be evaluated taking into account an interval of about four years. The IPs are expected to be registered in FY2024 and FY2025 if all goes well.

6.10 Status of Research Proposals Adopted by Joint Research Center for Advanced and Fundamental Mathematics-for-Industry

Figure 6.13 summarizes the number of joint research projects conducted at IMI.

Figure 6.13 Number of IMI Joint Research Projects



This item is related to the “Joint Research Center for Advanced and Fundamental Mathematics-for-Industry” (Chapter 5), which is the centerpiece of IMI’s activities, and its adoption status is one objective indicator to measure whether users feel the value and attractiveness of using IMI as a joint research center.

Although the number of adopted proposals was small at the time of the establishment of IMI, the number has steadily increased since then, and has generally been on an increasing trend (with only one decrease in FY 2018), except for a significant decrease in FY 2020, which is thought to be due to behavioral restrictions triggered by the new coronavirus. and a further increase in FY2022. In FY2021, the expansion of implementation modes (Online, In-Person, and Hybrid) through behavioral restrictions may have contributed to the significant increase in the number of proposals. These data reflect the fact that IMI’s activities have become more recognized and attractive over time.

6.11 Number of conference presentations

Figure 6.14 shows the number of conference presentations made by IMI faculty members.

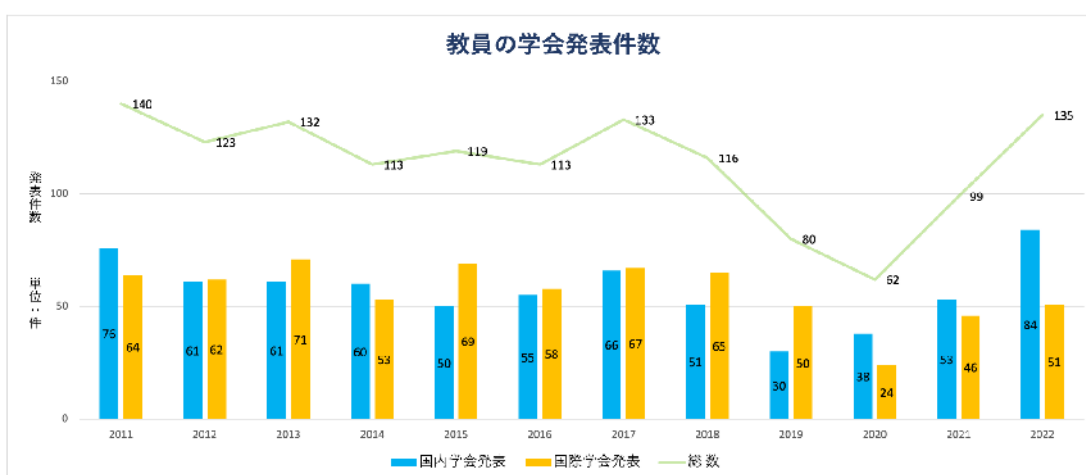
Note: These data are collected from different sources for “before FY2021” and “FY2022”.

Therefore, the relationship between the two should be viewed *only as a reference*.

They affect data collection methods and management systems. Details are mentioned at the beginning of this chapter.

Figure 6.14 Number of Conferences, Research Meetings, and Seminars Presented by IMI Faculty

IMI教員 学会発表 件数 (件)												
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
国内学会発表	76	61	61	60	50	55	66	51	30	38	53	84
国際学会発表	64	62	71	53	69	58	67	65	50	24	46	51
総数	140	123	132	113	119	113	133	116	80	62	99	135



IMI faculty members are vigorously developing their conference presentations both domestically and internationally. An interesting result is that the overall trend is “more international conference presentations than domestic conference presentations” until FY2019. While there may be a trend in the field, it is thought that IMI faculty members as a whole are more conscious of international presentations than domestic ones. However, this is reversed after FY2020.

In FY 2019, both domestic and international presentations are decreasing, but this is expected to reflect the fact that some conferences were canceled due to the ICIAM (International Congress on Industrial and Applied Mathematics) in Spain, and that conferences in February and March of the same year were forced to be canceled due to the impact of the new coronavirus epidemic that began in early FY2020.

After FY2020, the number of conferences was also affected by the cancellation of conferences themselves due to travel restrictions and behavioral restrictions caused by the new coronavirus, but in FY2021, the number of both domestic and international conferences (including those held online) is on a recovery trend. In fact, the number of presentations at international conferences itself recovered to the pre-FY2019 level in the following year. On the other hand, the number of presentations at domestic academic conferences has increased more rapidly than that since

FY2021, and the number of presentations at domestic academic conferences reached a record high in FY2022.

Note: These data are based on Q-RADeRS to collect information, but the numbers may vary depending on the data input by individual faculty members. For example, Q-RADeRS is designed to record “conferences”, but it is unclear whether “research meetings” and “seminars” are included in this category. Some faculty members added the latter, while others did not. Due to the huge number of surveys that accompanied the survey this time, it was not possible to make a sharp distinction between the data to be included, and those that were declared in Q-RADeRS are listed as they are. For these reasons, the number of pure “conference presentations” or “presentations including research meetings and seminars” may be slightly higher or lower.

6.12 Number of papers published

The research articles authored by IMI faculty members are summarized in Figures 6.15 and 6.16. The numbers are “Number of International Journals + Number of Domestic Journals”, “Number of Journals + Number of Proceedings”, and “Number of Refereed + Number of Non-refereed” are equal to “Total Number of Papers”, respectively. Books are included in Journals.

Figure 6.15 Number of Publications by IMI Faculty Members
(Figure shows changes in international/domestic journals)

	論文総数	国際誌	国内誌	Journal	Proceedings	査読あり	査読なし
2011	39	35	4	28	11	35	4
2012	58	47	11	40	18	47	11
2013	74	64	10	44	30	62	12
2014	68	66	2	40	28	58	10
2015	49	48	1	28	21	42	7
2016	69	68	1	52	17	64	5
2017	52	50	2	37	15	50	2
2018	55	52	3	43	12	46	9
2019	65	62	3	52	13	61	4
2020	68	65	3	48	20	67	1
2021	85	77	8	47	38	74	11
2022	84	73	11	55	29	72	12

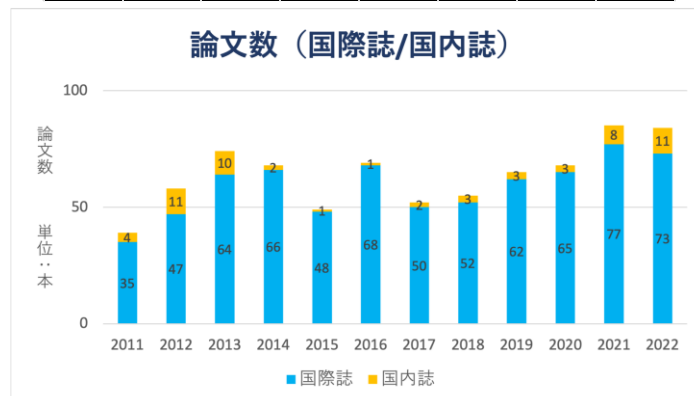
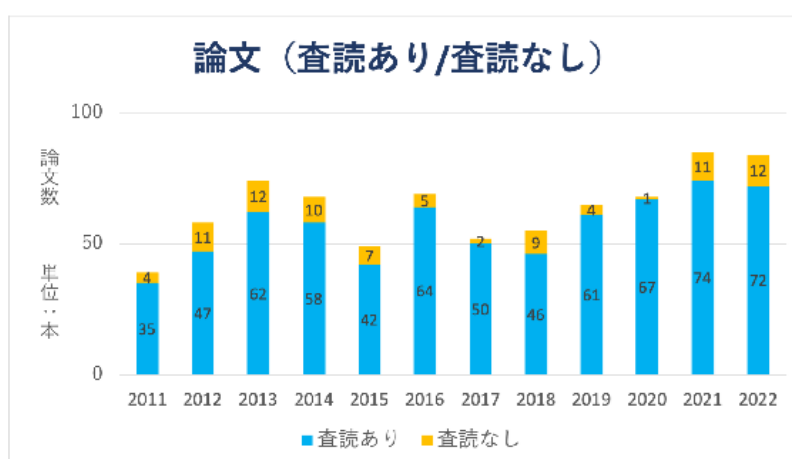
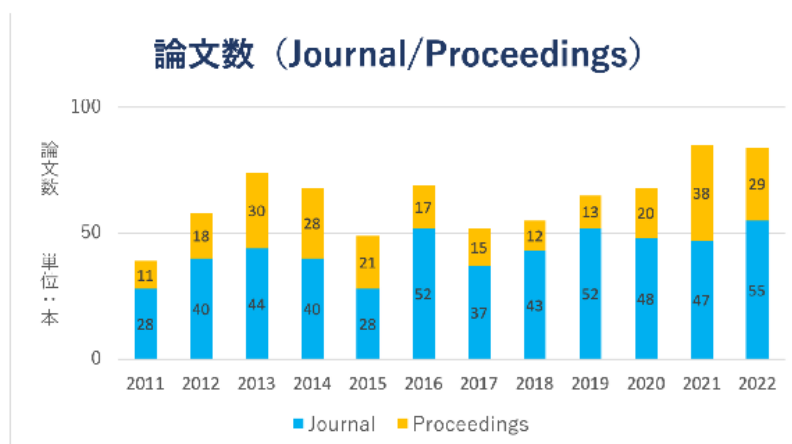


Figure 6.16 Number of papers published by IMI faculty
(differentiated by journal/ proceedings, peer-reviewed or not)



Since its establishment, the total number of papers has continued to increase, except for a few years. Most of them are international journals.

Furthermore, although not perfect, the number of “refereed” papers and the number of “international journals” are almost the same, so it is safe to assume that “almost all papers published in international journals have been peer-reviewed.”

The fields in which IMI faculty members are engaged in are diverse, including mathematics, and it is not unusual for some fields to take one to two years for peer review. Therefore, we need to be a little careful in assuming that “publication year” = “year in which research results were obtained”, but even under such circumstances, the number of publications in “Journals” has been stable.

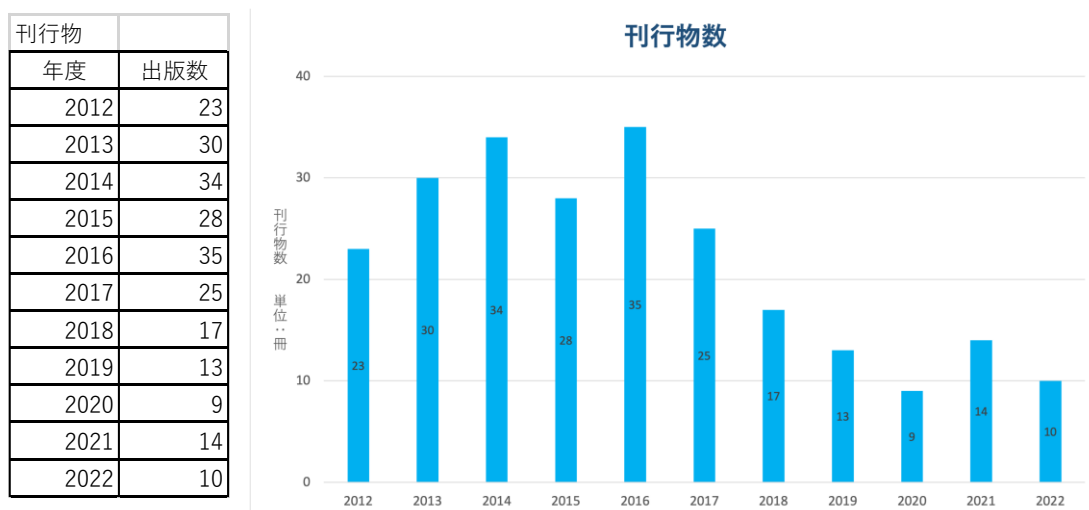
On the other hand, "Proceedings" mostly include research meetings and conferences, and the number of publications may fluctuate depending on the year of the meeting or the time of compilation. In such a situation, despite the restriction of activities due to the new coronavirus from FY2020, there has been no decrease in the number of Journals and Proceedings. Rather, the number of Proceedings has increased dramatically since FY2021. This is due to the arrival of Prof. Koji Nuida, an expert in cryptology, at IMI from FY2021, and the publication of many Proceedings by his research group. Although there are aspects that depend on the characteristics of the faculty member's field, it can be said that we have generally been able to achieve a stable publication of research results, regardless of whether there are action restrictions.

Finally, this report does not include a tally of papers published in world-class journals, such as "Top 10% papers". This is because there are so many papers and journals, and we were unable to trace back information on journal rankings in the past. To develop IMI in the future, it is important to pay attention to the Top 10% papers, which are one of the objective indicators to measure research power, and an information strategy to collect and utilize such information in a uniform manner is required for the development of IMI.

6.13 Publications from IMI

Figure 6.17 summarizes the IMI-led publications.

Figure 6.17: IMI Publications



First, "Journal of Math-for-Industry," a journal that solicits research results in mathematics-for-industry, is published once a year. This journal was published in FY2009, before the IMI was

established, and was renamed "Pacific Journal of Mathematics for Industry" in FY2014 and "International Journal of Mathematics for Industry" in FY2018.

Major publications contributing to the increase in the number of publications are "MI Lecture Notes", "Mathematics for Industry (Springer Book Series)" and "IMI Newsletter". The MI Lecture Notes are a compilation of presentations and lecture transcripts from SGW and IMI-sponsored workshops. "Mathematics for Industry" is the Proceedings of the IMI-led International Research Conference, which has been published extensively since 2014. The Newsletter is a quarterly publication that provides a concise summary of information on activities within and outside of IMI and is published in three copies per year.

The "MI Preprints" are also published until FY2019. More than 10 (20 or more in some years) were published until FY2016, but the number of publications has sharply decreased since FY2017 and ceased after FY2019.

6.14 Courses Taught by IMI Faculty

The transition of lectures given by IMI faculty members is summarized in Figures 6.18 to 6.22.

Figure 6.18 Number of Courses Taught by IMI Faculty in the Mathematics Department

数学科の授業に対するIMI教員の担当科目数							
年度	2016	2017	2018	2019	2020	2021	2022
開講授業総数	55	55	55	54	53	47	48
IMI教員担当	20	18	20	21	23	22	22
他の教員担当	35	37	35	33	30	25	26

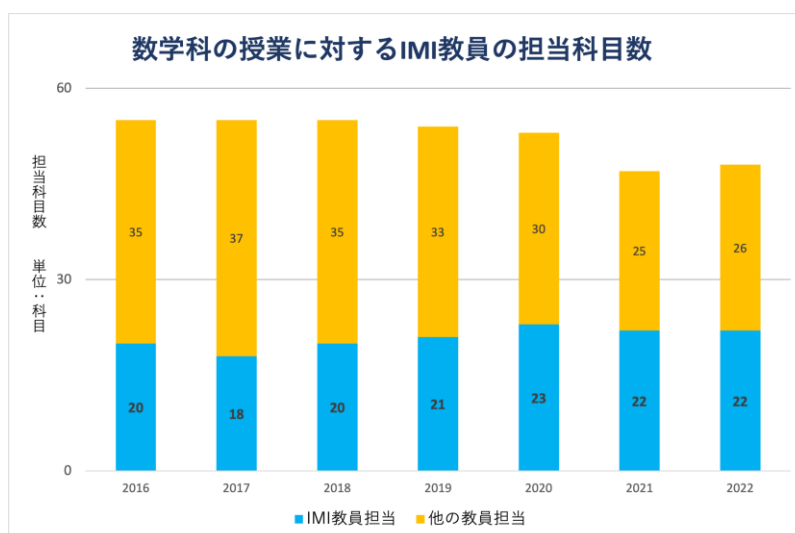


Figure 6.19: Number of Courses Taught by IMI Faculty in the Graduate School of Mathematics

数理学府の授業に対するIMI教員の担当科目数							
年度	2016	2017	2018	2019	2020	2021	2022
開講授業総数	41	44	44	44	46	42	48
IMI教員担当	25	30	23	23	25	21	33
他の教員担当	16	14	21	21	21	21	15

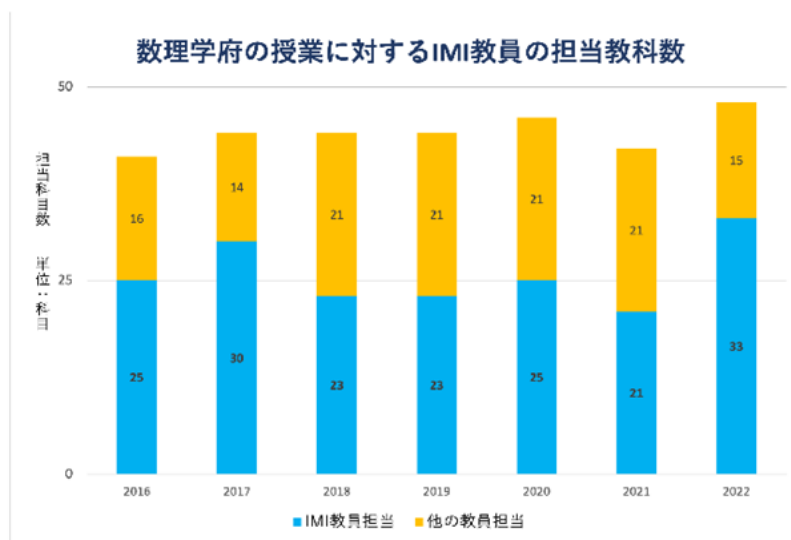


Figure 6.20: Number of Courses Taught by IMI Faculty in the Engineering Department

工学部の授業に対するIMI教員の担当科目数							
年度	2016	2017	2018	2019	2020	2021	2022
開講授業総数	10	27	25	28	22	24	26
IMI教員担当	9	22	20	23	17	19	24
他の教員担当	1	5	5	5	5	5	2

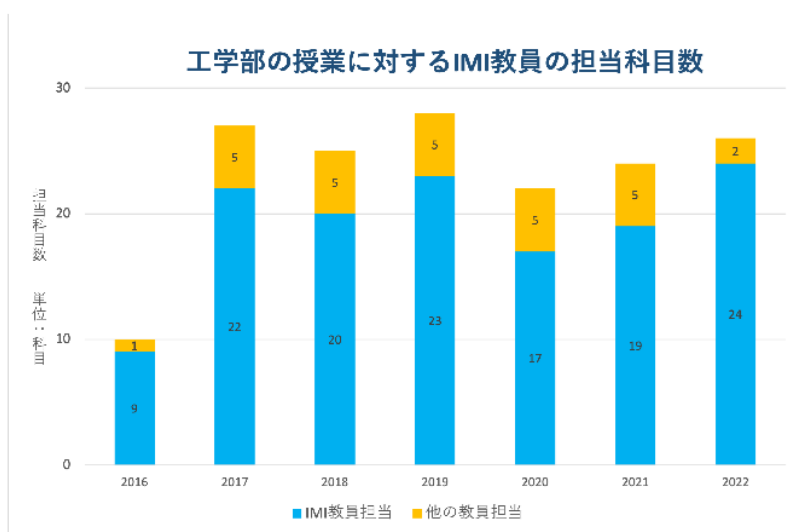


Figure 6.21 Number of "Core Education" courses taught by IMI faculty

	IMI教員担当科目数	基幹教育と数学科で重複して担当している科目数
2016	4	1
2017	4	2
2018	4	1
2019	2	4
2020	2	3
2021	4	2
2022	4	4

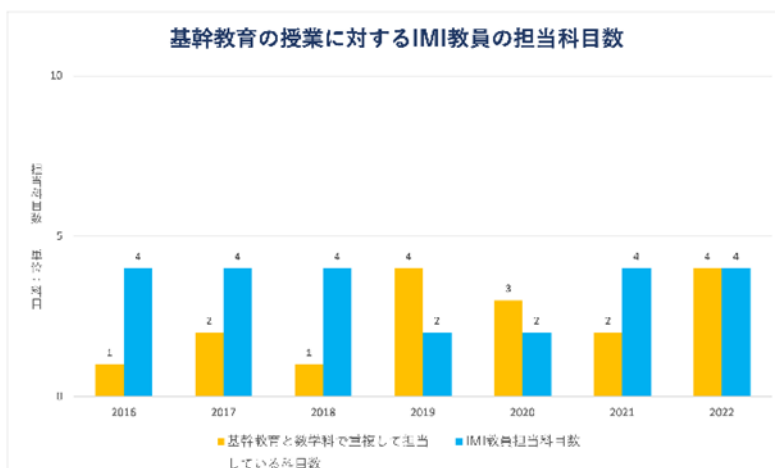
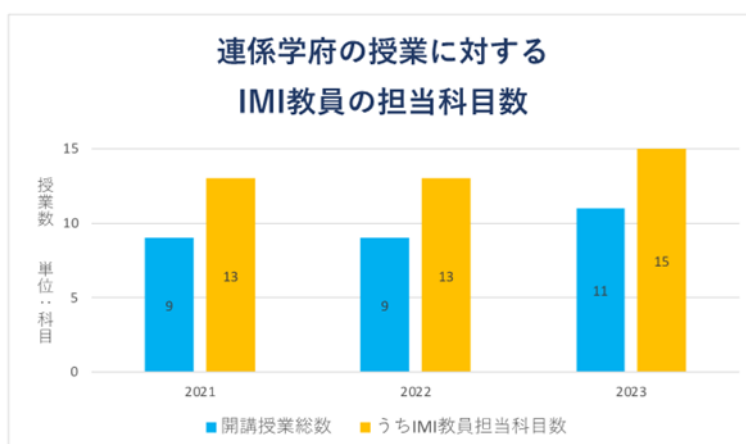


Figure 6.22 Number of Courses Taught by IMI Faculty Members in JGMI (see Chapter 10)

連係学府の授業に対するIMI教員の担当科目数			
年度	2021	2022	2023
開講授業総数	9	9	11
うちIMI教員担当科目数	13	13	15

※開講授業総数は、数理学府との相乗りも含む
 ※IMI教員相当科目数は、連携学府の2人を含む、オムニバス含む



Lectures are broadly classified into “School of Mathematics (Undergraduate)”, “Graduate School of Mathematics”, “School of Engineering (Undergraduate)”, “Arts and Science”, and “Joint Graduate School of Mathematics for Innovation (*JGMI* for short)”.

Overall, the number of lectures has remained flat. Although there is a decrease in the number of lectures given by some IMI faculty members, it is in line with the overall decrease in the number of lectures, which is a trend.

The number of lectures decreased in FY2020, possibly due to the restriction of activities associated with the spread of the new coronavirus, but the number of faculty members in charge of IMI increased again in FY2021. It is safe to say that the impact of this change is negligible. On the other hand, the Faculty of Engineering will undergo organizational restructuring, and the accompanying reorganization of lectures will be implemented from FY2024. As a result of the reorganization, the number of lectures in the School of Engineering is expected to decrease significantly.

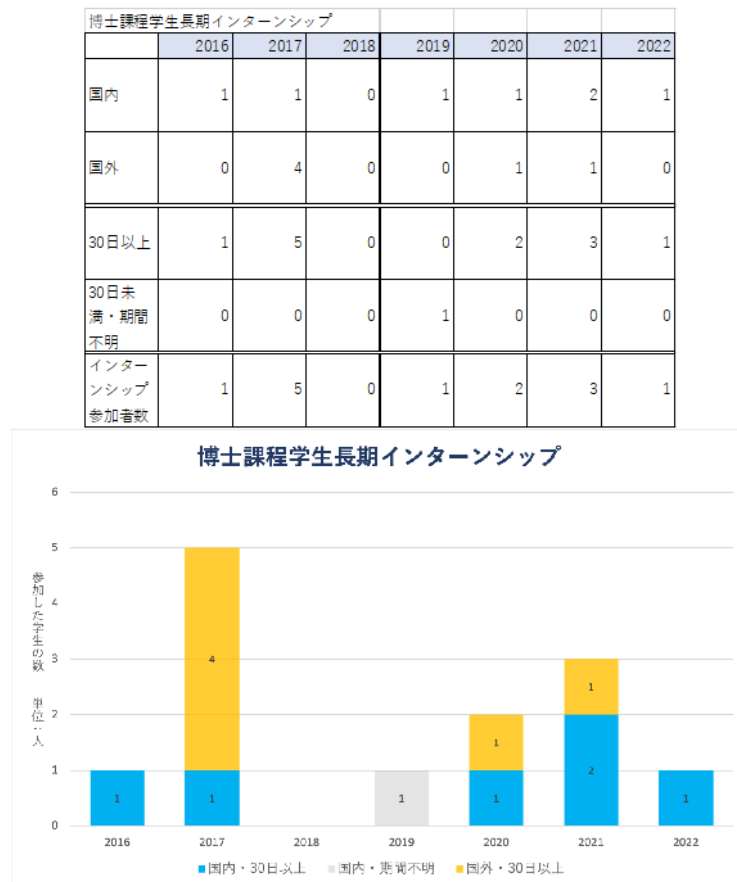
As for the core education lectures, a certain number of lectures (linear algebra, differential and calculus, programming, etc.) are offered each year by IMI faculty as well as faculty from the Graduate School of Mathematics. It is assumed that the variation in the number of lecturers from year to year is limited to a fifty-fifty split with the faculty of the Graduate School of Mathematics.

The reason why the number of faculty members in charge is larger than the number of lectures in JGMI is due to the fact that several "omnibus lectures" are offered by multiple faculty members, reflecting the fact that two to four faculty members are in charge of one lecture.

6.15 Long-term internship for doctoral students

Long-term internships experienced by doctoral students are summarized in Figure 6.23.

Figure 6.23 Trends in Long-Term Internships for Doctoral Students



The long-term internship program is offered to mathematics students at Kyushu University (including the Graduate School of Mathematics and JGMI, as mentioned later). The target students are not asked whether they belong to the IMI or the Graduate School of Mathematics, so these data do not distinguish between the two.

In principle, “long-term” internships are expected to last 30 days or longer. In fact, almost all of the students surveyed in this study have completed at least 30 days of internship. And a certain number of students, both in Japan and abroad, achieve an internship every year. Although the implementation of internships is affected by social conditions in Japan and abroad, as well as by the internal situation of companies, it is commendable that the company can find internship sites and send out a certain number of students regardless of these conditions.

Perhaps due to the development of online-based activities, there was no clear correlation between the number of internships and the behavioral restrictions associated with the new coronavirus.

6.16 Research Internship with Consulting

The “*Research Internship with Consulting*” is a system launched by IMI in 2021 to combine human resource acquisition (internship and education) and consulting, aiming to ensure a minimum level of effectiveness and to provide a clue to further development of cooperation. The “Career and Scholarship Support Section of the Academic Affairs Department” and the “Academic Research and Industrial Collaboration Management Office Advisor/Research Internship Coordinator” act as intermediaries, and joint research sites are determined through discussions between students, IMI consulting faculty, and internship companies using C-ENGINE (*).

Table 6.24 below summarizes the results of internships conducted under the “Research Internship with Consulting” program.

(* This is the council “**C**ollaborative **E**ducation for **N**ext- **G**eneration **I**Nnovators & **E**xploration of knowledge intersections”.)

Table 6.24 Long-term Internships for Doctoral Students

Period	Company categories	Field
2021, 1 month	Social Infrastructure Company	Time-Series Analysis
2021, 1 month	Social Infrastructure Company	Time-Series Analysis
2021, 2 months	Metal Processing Company	Shape Processing
2021, 2 months	Metal Processing Company	Shape Processing
2021, 1 month	Game Development Company	Deep Learning
2021, 1 month	Game Development Company	Natural Language Processing
2022, 3 months	Social Infrastructure Company	Statistical Modeling
2022, 1 month	Electronic component manufacturer	Statistical Modeling
2023, 2 months	Social Infrastructure and manufacturing Company	Statistical Modeling

2023, 3 months	Game Development Company	Natural Language Processing
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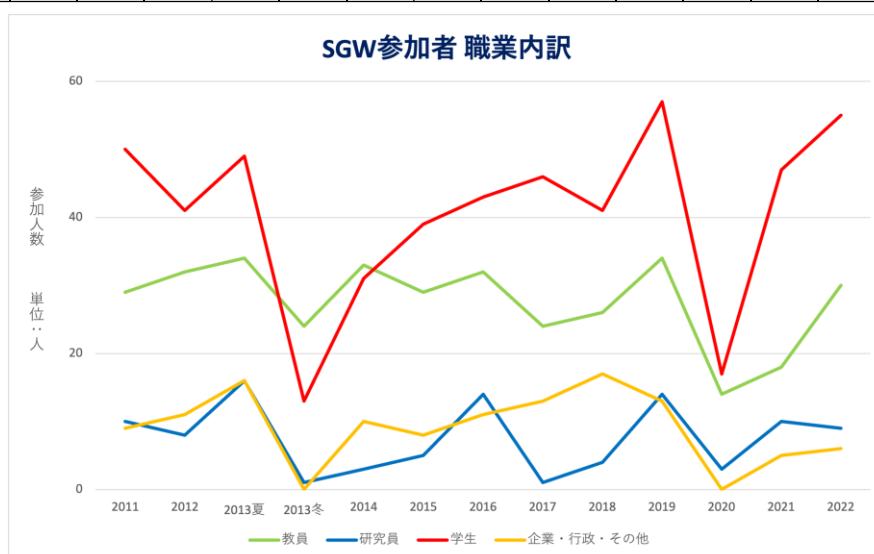
6 students among those who engaged in internships got jobs there or affiliated companies. Other students have not reached the graduation year or have not responded to the career path.

6.17 SGW Participation

The number of participants in *Study Group Workshops* (SGWs for short) is summarized in Figure 6.25.

Figure 6.25 Breakdown of Study Group Workshop (SGW) Participants

SGW参加者内訳(職種別)															
	2011	2012	2013夏	2013冬	2014	2015	2016	2017	2018	2019	2020	2021	2022	合計	
教員	29	32	34	24	33	29	32	24	26	34	14	18	30	359	
研究員	10	8	16	1	3	5	14	1	4	14	3	10	9	98	
学生	50	41	49	13	31	39	43	46	41	57	17	47	55	529	
企業・行政・その他	9	11	16	0	10	8	11	13	17	13	0	5	6	119	



Since SGW is co-sponsored by the Graduate School of Mathematical Sciences of the University of Tokyo, the main participants will be from IMI, Kyushu University, the Graduate School of Mathematics, and the Graduate School of Mathematical Sciences of the University of Tokyo. The composition of participants is categorized as “faculty”, “researchers”, “students”, and “business and government officials” and others.

As a prerequisite, five to six problems are submitted to SGW every year, and the submitters are researchers from companies and research institutes. The participants include those involved in the research.

First, the number of participants in FY2020 has decreased dramatically, as if to reflect the real impact of the behavioral restrictions associated with the new coronavirus. However, this fiscal year was unique in that only one assignment was submitted; although the number of student participants in FY2021 was also very low compared to previous years, with two assignments, the number of student participants recovered to the previous year's level.

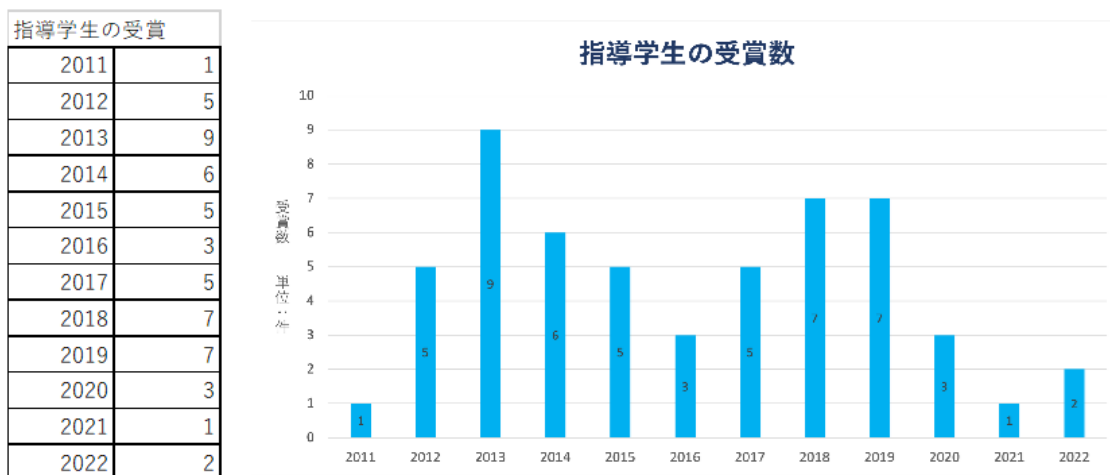
In addition, there were two meetings with zero “business and government” participants. The first was in winter FY2013 and the second was in FY2020. As mentioned earlier, the participants included the submitters, and in fact, there were no issues submitted by companies at these meetings. It is worth noting that the “number of student participants” dropped sharply at these times, and only at these times, and while it is possible that the winter FY2013 meeting overlapped with the lecture period and the period of academic conferences and research meetings, it is worth considering the possibility that the numbers reflect the potential interest of students in the participation of companies.

Since the number of participants, including both faculty and researchers, has always remained almost unchanged, the “number of student participants” may be one indicator of the excitement of SGW.

6.18 Student Awards

The award records of students supervised by IMI faculty are summarized in Figure 6.26. Awards for student presentations and papers are an indicator not only of the excellence of the research activities of the student concerned, but also of the quality of education by Faculty members. Note that these data do not include students supervised by faculty members of the Graduate School of Mathematics.

Figure 6.26 Number of awards received by IMI faculty mentored students



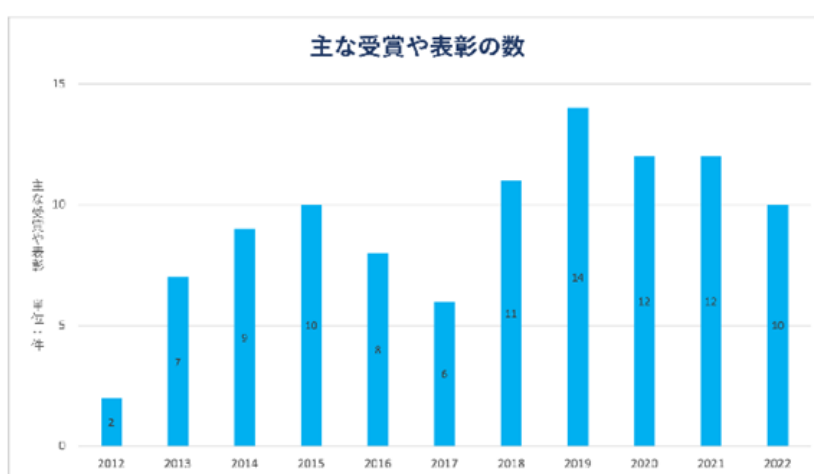
As far as the data shows, there are quite a few student awards received each year. Most of the awards are given to students who participate in events that are conscious of industry-academia collaboration, such as “FMfl (Forum “Math-for-Industry”, mentioned in Chapter 8)” and “Cross-disciplinary and cross-industrial research exchange meetings”, which IMI also participates in planning, as well as Operations Research, information security and other information-related academic societies. On the other hand, the number of students who have participated in such events is expected to decrease sharply from FY2020. On the other hand, the number of students who participated in such events has drastically decreased since FY2020. This is thought to be partly due to a combination of cancellations of conferences and international meetings with awards (such as FMfl) due to the impact of action restrictions.

6.19 Faculty Awards

The award records of IMI faculty members are summarized in Figure 6.27.

Figure 6.27: Number of awards received by IMI faculty

主な受賞や表彰の数		主な受賞や表彰				
年	数	【Graph500】	【日本数学会】	【藤原洋数理科学賞】	受賞及び表彰	年度計
2012	2			1	1	2
2013	7			1	6	7
2014	9	2	1		6	9
2015	10	2	2		6	10
2016	8	2	1		5	8
2017	6	2			4	6
2018	11	2			9	11
2019	14	2		1	11	14
2020	12	2		1	9	12
2021	12	2			10	12
2022	10	2			8	10
計		18	4	4	75	101



Despite the research trends and intense competition, the group has recorded more than a certain number of awards each year.

Of particular note is the “World No. 1 Graph500 Benchmark” by Prof. Fujisawa's group, which has been awarded more than 10 times, testifying to the high global level of the group's research.

On the other hand, most of the awards are concentrated on lectures and papers in optimization theory, informatics conferences, and cryptography. This confirms the high level of the Firm's research in the relevant theories.

In addition, four IMI faculty members (then and now included) have received *the Hiroshi Fujiwara Prize for Mathematical Sciences*, which recognizes the contributions of researchers who have developed mathematical theories that have useful applications in real society, or who have discovered applications of mathematics that are useful for the development of society. These achievements demonstrate that IMI is making a high level of “contributions to society using mathematics”.

7. IMI Manifesto 2021

In April 2021, IMI celebrated its 10th anniversary.

In conjunction with this event, the “*IMI Manifesto 2021*”, which summarizes IMI's new commitment, was issued under the name of Osamu Saeki (Director of IMI in April 2021), then director of IMI.

This chapter introduces the text of the IMI Manifesto 2021, followed by a summary of the “Mission” and “Activities” announced under the IMI Manifesto 2021.

7.1 IMI Manifesto 2021

The Institute of Mathematics for Industry (IMI) at Kyushu University was established in April 2011 as an affiliated research institute at Kyushu University, and since then has promoted collaboration and exchange with industry and a variety of academic fields, achieving results not only in research but also in human resource development. In FY2020, the IMI was selected by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) for its “*Graduate Program of Mathematics for Innovation*”, which is centered on the IMI, and is striving to develop human resources who can co-create and generate new ideas with researchers in various fields through mathematical modeling based on a deep understanding of data. The Institute has also played an important role in building an international network and has become a leading institution in activities related to mathematics-for-industry, especially in the Asia-Pacific region.

In recent years, mathematics has played an increasingly important role as the foundation of industry. The social significance of mathematics has long been recognized in Europe and the United States, and in Japan, the importance of mathematics as an indispensable science to lead the fourth industrial revolution has been emphasized in the report “The Age of Mathematical Capitalism: The Power of Mathematics to Change the World” published by MEXT in the year before last. At the same time, the use of mathematics is expanding, not only in fields that have traditionally been linked to industry, such as numerical analysis, mathematical optimization, and statistics, but also in fields that have not had a conspicuous relationship with industry, such as algebra and geometry, where mathematics is collaborating with a wide range of academic fields, including information, materials, life, energy, finance, and law, and contributing to the development of related industries. “Mathematics for Industry (Mfi)”, the name of our institute, refers to a new type of mathematics that transcends the boundaries of conventional disciplines to respond to such demands from both society and academia.

As the IMI celebrates its 10th anniversary in 2021, we hereby express our commitment and ask for further cooperation in various fields to further promote the collaboration and exchange with different fields that we have been working on and to create new mathematics that will contribute to technological innovation in industry. As a center of Mfl, we declare that we will continue to contribute to society as a cornerstone for the development of mathematics-for-industry by working with industry to promote the deepening of mathematics-for-industry, a new field of mathematical research, to foster human resources with a high awareness of industry and mathematical ability, and to create organic linkages that make use of mathematics in industry.

Osamu Saeki
Director, Institute of Mathematics for Industry, Kyushu University
(April 2021)

7.2 Mission

Under the IMI Manifesto 2021, IMI has established the following as the mission of the organization.

- Solving various problems in industry and developing mechanisms for universities to work with industry to solve problems.
- Develop human resources with high mathematical ability and co-creation ability to contribute to industry and build a system necessary for this purpose.
- Pioneering new mathematics that promotes breakthroughs in technological development in industry and creates innovation through exchanges between industry and universities.
- Support for researchers and engineers belonging to industry to make use of pioneered mathematical knowledge.
- Awareness-raising for correct social implementation of mathematical methods, avoiding risks such as financial crisis, fairness issues of machine learning, and security compromises.

7.3 Activities

The following activities are listed in accordance with the IMI Manifesto (in principle according to the original text, with some modifications).

- Provide various events and networking opportunities to promote interaction and mutual understanding between industry and universities as a MEXT-approved “Joint Research Center for Advanced and Fundamental Mathematics-for-Industry”.
Support for finding partners to take on advanced projects that are difficult for a single

company to undertake Support for finding partners to take on advanced projects that would be difficult for one company to undertake alone.

- Seminars and tutorials will be organized to provide the latest information on mathematics-for-industry, to share issues in industry, and to identify new research themes.
- To promote joint research between industry and universities, IMI accepts and matches proposals and develops new research and development.

IMI also provides technical consultation services by IMI-affiliated researchers. The network established by *the Advanced Innovation powered by Mathematics Platform* (AIMaP, see Chapter 11), a project commissioned by MEXT for experimental research on science and technology, will be utilized.

- To plan and organize events as a place to pioneer new mathematics that will create technological innovation in industry, or to foster human resources who will use the advanced mathematical knowledge they have pioneered in industry. Study Group Workshop (SGW) will be held annually to receive and explore solutions to problems raised by industry.
- Promote the development of human resources for mathematics-for-industry, including the Graduate Program of Mathematics for Innovation. In addition, the program will financially support motivated students.
- Actively implement long-term research internships to cultivate students' problem-solving skills in industrial settings and to increase opportunities for companies to utilize advanced mathematics personnel in their operations. In addition, we will constantly examine and propose better forms of internships that benefit both companies and universities.
- Establish a system to accept engineers and researchers from industry as working doctors, centering on the Graduate Program of Mathematics for Innovation.
- Establish opportunities for industry to send researchers to universities and participate in the education of graduate students through lectures and seminars.
- Universities dispatch researchers to industries and conduct activities to support engineers in acquiring mathematical knowledge through lectures and seminars.
- In addition to publishing academic papers, commentary articles, and books to make the latest results available to the public, we will disseminate information and conduct educational activities related to mathematics-for-industry through outreach activities such as newsletters and lectures.
- Build an international network in cooperation with overseas academic institutions and companies by holding international workshops and sending and receiving students.

- To collect and share information on trends in mathematical scientific research in overseas industries in cooperation and collaboration with national institutions.

7.4 Others

The IMI Manifesto 2021 invites companies, academic organizations, and individuals to support the IMI Manifesto by cooperating with any of the following to promote the development of mathematics-for-industry.

- (For companies and organizations) Acceptance of doctoral students for long-term research internships (3 months or longer)
- (For companies and organizations) Employment of advanced mathematics personnel, including post-doctoral fellows, and development of a flexible hiring structure to utilize mathematics personnel.
- (For companies, organizations and individuals) Joint Research/Commissioned Research
- (For companies, organizations and individuals) Dispatch of lecturers to seminars and workshops
- (For companies, organizations and individuals) Participation in and support for workshops and other events

(For companies, organizations and individuals) Donation to the “Project for Human Resource Development in Mathematics-for-Industry” (Section 3.2) of the Kyushu University Fund for specific use

8. APCMfi

This chapter summarizes “the Asia-Pacific Consortium of Mathematics for Industry”.

8.1 Purpose

APCMfi, the Asia Pacific Consortium of Mathematics for Industry, was launched on April 2, 2014, to subsidize the development of *Mathematics for Industry* (“*Mfi*” for short) in the Asia Pacific region, to coordinate joint projects of mutual interest, and to otherwise increase employment opportunities for students in mathematics fields through Mfi in industry, government and local governments, and to increase employment opportunities for students in mathematics through Mfi.

The Mfi promotes the development of mathematics and its applications to further improve the quality of life of people by creating new technologies, furthering mathematical research in industry, and stimulating the interrelationship between industry and mathematics.

8.2 Activities

In order to achieve these objectives, APCMfl promotes exchanges, conferences, internships and other activities related to mathematics as follows:

- To support graduate student internships in industrial and government research projects. In this internship, the student stays for a total of several months at the destination country and participates in the project.
- Facilitate the acquisition of internships in industry outside the Asia-Pacific region.
- Support the mathematics-for-industry study groups already in place in Japan, Australia, and Malaysia (as of April 1, 2014) to achieve regular meetings and encourage participation.
- *Forum “Math-for-Industry”* (see below), which was successfully organized by IMI, will be held on a regular basis.
- Exchange and share information related to mathematics-for-industry in the Asia-Pacific region through electronic newsletters, publications, and websites.
- Organize joint lecture programs such as summer and winter schools in the Asia-Pacific region.
- To promote a strong two-way exchange of mathematics and statistics researchers and research institutions and mathematics-for-industry needs.

In reality, the main activity is the organization of the Forum “Math-for-Industry,” which will be mentioned later, while other activities are limited to the sharing of information on events held by individual participating organizations.

8.3 Committee

As of April 1, 2021, the committee members (officers) are as follows.

President	Zainal Aziz (UTM, Malaysia)
Vice President	Philip Broadbridge (La Trobe University, Australia)
Secretary	Kenji Kajiwara (IMI, Kyushu University, Japan)
Accountant	Shizuo Kaji (IMI Kyushu University, Japan)
Publicity	Melanie Roberts (School of Environment and Science - Applied Mathematics and Physics Griffith University, QLD, Australia)
Chief Editor of IJMI	Masato Wakayama (NTT Institute for Fundamental Mathematics, JST/CRDS, Japan)

Other committee members

Busayamas Pimpunchat (King Mongkut's Institute of Technology Ladkrabang, Thailand)

Mark McGuinness (Victoria University of Wellington, New Zealand)

Anthony Jakeman (Australian National University, Australia)

Yichao Zhu (Dalian University of Technology)

Chu Delin (National University of Singapore)

Kerrie Mengersen (QUT, Australia)

Soon-Sun Kwon (Department of Mathematics, Director of Ajou center for mathematics and statistics in industry, Ajou University, Korea)

Natalie Thamwattana (School of Mathematical and Physical Sciences University of Newcastle, NSW, Australia)

8.4 Forum “Math-for-Industry”

Forum “Math-for-Industry” (“FMfI” for short) is an annual international research meeting on mathematics-for-industry organized by APCMfI. The purpose of FMfI is to promote collaboration and knowledge sharing among mathematicians in different fields, starting from mathematical theory and applications.

The meeting consists of the following two parts:

[Invited Lectures]

Lectures by world-class researchers on major themes; all FMfI lectures are invited talks.

[Poster Session]

In addition to the invited lectures, FMfI holds poster sessions for students and young researchers. In this session, the Best Poster Award and Excellent Poster Award are established, and outstanding presentations are given the honor of “outstanding poster presentation,” which is equivalent to these awards, and a “one-month overseas research stay” and “two-week overseas research stay”, respectively, as supplementary prizes. This event provides students with an opportunity to present their research at international conferences and promotes research through supplementary prizes.

The meeting itself has been held since 2009 but was co-sponsored by Kyushu University (mainly IMI) from 2011 to 2013 and by APCMfI since 2014.

It will be counted 15 times at FMfI: Forum “Math-for-Industry” 2023 - MfI 2.0 - in 2023.

The following is a list of FMfI venues and major themes for each year. All the events held in Fukuoka were hosted by IMI.

2008(Tokyo) (No specific themes)

2009(Fukuoka), Casimir Force, Casimir Operators and the Riemann Hypothesis –Mathematics for Innovation in Industry and Science–

2010(Fukuoka), Information Security, Visualization, and Inverse Problems, on the basis of Optimization Techniques

2011(Honolulu, Organizing: University of Hawaii at Manoa), "TSUNAMI - Mathematical Modelling" Using Mathematics for Natural Disaster Prediction, Recovery and Provision for the Future

2012(Fukuoka), Information Recovery and Discovery

2013(Fukuoka), The Impact of Applications on Mathematics

2014(Fukuoka), Applications + Practical Conceptualization + Mathematics = Fruitful Innovation

2015(Fukuoka), The Role and Importance of Mathematics in Innovation

2016(Brisbane, Organizing: Queensland University of Technology), Agriculture as a Metaphor for Creativity in All Human Endeavors

2017(Honolulu, Organizing: University of Hawaii at Manoa), Responding to the Challenges of Climate Change: Exploiting, Harnessing and Enhancing the Opportunities of Clean Energy

2018(Shanghai, Organizing: Fudan University), Big Data Analysis, AI, Fintech, Math in Finances and Economics

2019(Auckland, Organizing: Massey University), Mathematics for the Primary Industries and the Environment

2021(Hanoi, Organizing: Vietnam Institute for Advanced Study in Mathematics), -Mathematics for Digital Economy-

(2020: postponed due to COVID-19)

2022(Melbourne, Organizing: La Trobe University), -Mathematics of Public Health and Sustainability-

2023(Fukuoka), - MfI 2.0 -: ICIAM2023 Satellite Meeting

9. Australia Branch

As mentioned in Chapter 1, *IMI's Australian Branch* was established at La Trobe University in Melbourne, Australia, in March 2015, and activities at La Trobe University include many that IMI supported starting from the Australian Branch. This chapter summarizes the joint activities of La Trobe University and IMI, as well as IMI's participation in events held in the Oceania region.

9.1 Faculty Staffs, etc.

The full-time faculty members of the Australia Branch are summarized below.

Cesana Pierluigi

In September 2015, he joined the Australian Branch of La Trobe University as an Associate Professor.

In April 2017, he moved to the IMI Australia Branch at Kyushu University (Ito) as an Associate Professor.

He has been in his current position since the same period (as of October 1, 2023).

Dimetre Triadis

March 2015: moved to the Australian Branch of La Trobe University as Assistant Professor (fixed-term faculty).

April 2017: transferred to the Australian Branch of IMI at Kyushu University (Ito) as Assistant Professor (fixed-term faculty).

October 2018: Moved to La Trobe University's Australian Branch as an Assistant Professor (fixed-term faculty member).

End of September 2022: Term expires.

Thereafter, he will be appointed as a faculty member at La Trobe University.

Daniel Mircea Gaina

April 2017: moved to the Australian Branch of IMI at Kyushu University (Ito) as Assistant Professor (Distinguished Researcher).

November 2017: transferred to the Australian Branch of La Trobe University as Assistant Professor (Distinguished Researcher).

December 2018: transferred to IMI Australia Branch at Kyushu University (Ito) as Assistant Professor (Distinguished Researcher).

April 2022: Promoted to Associate Professor at IMI Australia Branch, Kyushu University (Ito).

Current position from the same period (as of October 1, 2023).

Yasuhide Fukumoto

Professor and 2nd Director of IMI (October 1, 2014~September 30, 2018).

July 1, 2018 - June 30, 2021: Visiting Professor (Adjunct Professor), La Trobe University.

Kenji Kajiwara

Professor and Director of IMI.

July 1, 2018 - June 30, 2021: Visiting Professor (Adjunct Professor), La Trobe University.

Philip Broadbridge

Head of Operations, La Trobe University, Australia Branch.

He retired at the end of 2018.

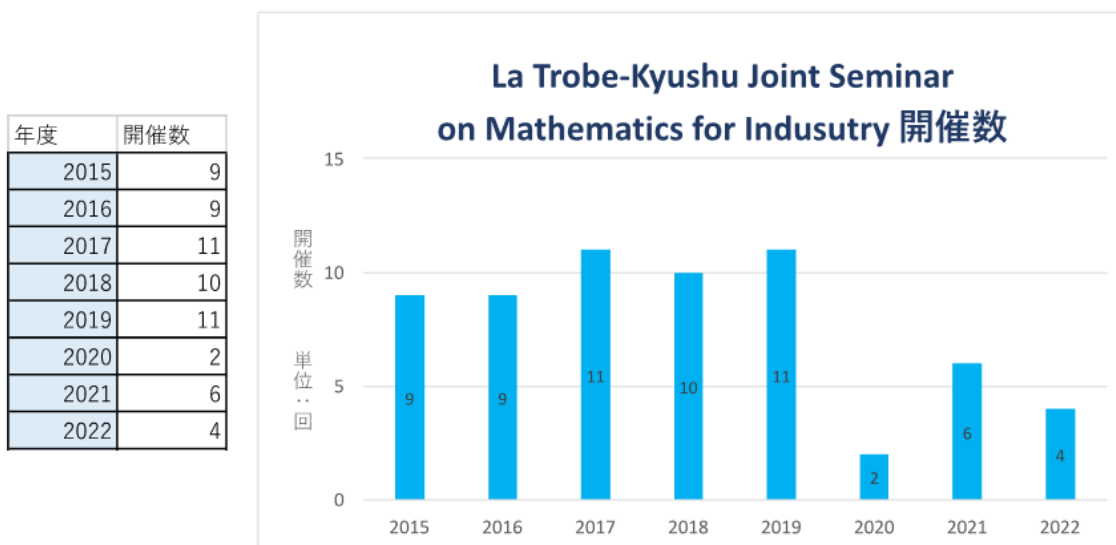
The laboratory has been taken as before and research activities continue.

9.2 La Trobe-Kyushu Joint Seminar on Mathematics for Industry

Since the establishment of the Australian Branch, Kyushu University IMI and La Trobe University have held a monthly online seminar during lunch time (Japan Standard Time) through the Australian Branch to promote researcher exchange between the two countries.

Figure 9.1 shows the actual number of events held.

Figure 9.1 Trend of La Trobe-Kyushu Joint Seminar on Mathematics for Industry held



9.3 Study group participation and interaction

Since 2015, students from La Trobe University and researchers from companies and universities in the Oceania region have also participated in Study Group Workshops (SGW) conducted at IMI.

FY	Students	Researchers
2015	2 (La Trobe)	6 (From a power transmission company in New Zealand)
2016		5 (From a power transmission company in New Zealand)

In addition, IMI faculty and Japanese researchers were dispatched to a study group in New Zealand in FY2016.

“Mathematics-in-Industry NZ, MINZ” (Total number of participants : 119)

<http://www.minz.nz.org/>

Dates: July 4 - July 8, 2016

Venue: Victoria University at Wellington

From Japan, JAMSTEC provided the problem, and 4 IMI faculty members and 3 domestic researchers participated.

(With the support of JSPS bilateral joint projects for the latter)

Certificate of Appreciation

On May 13, 2019 as an exchange between IMI and the Oceania region including La Trobe University,

Dr. Robert Anderssen (Commonwealth Scientific and Industrial Research Organisation, Australia),

Prof. Philip Broadbridge (Visiting Professor at IMI/Professor Emeritus at La Trobe University) were presented with a letter of appreciation from Kyushu University.

Dr. Anderssen has contributed to the management of IMI's international projects as a member of the International Advisory Committee since its inception and played a major role in creating an environment for IMI's international projects by leading the establishment of the Asia-Pacific Consortium for Mathematics for Industry (APCMfi) in 2016. In addition, he has made significant contributions to graduate education by establishing other awards for FMfi researchers.

Prof. Broadbridge was instrumental in establishing the IMI Australia Branch at La Trobe University in 2015.

For more information, see below:

<https://www.imi.kyushu-u.ac.jp/post-1832/>

9.4 MISG, ANZIAM

In Oceania, the “*Mathematics in Industry Study Group*” (MISG) and the “*Australian Mathematical Society*” (ANZIAM) study groups are held every year. Every year, IMI faculty members, students, and academic researchers participate in the study groups, including those led by the Australian branch of IMI. Table 9.2 shows the transition. The details of those that are available are shown below.

Table 9.2 MISG/ANZIAM Participation Trends

FY	MISG	ANZIAM
2015	6	3
2016	11 (Combined with ANZIAM: Total number of people. 1 faculty, 10 students)	11 (Combined with MISG: Total number of people. 1 faculty, 10 students)
2017	4 (Faculty 2, Students 2)	8 (Faculty 4, Students 4)
2018	6 (Faculty 2, Students 4)	5 (Faculty 4, Students 1)
2019	4 (Faculty 2, Student 1, Postdoc 1)	3 (Faculty 1, Students 2)
2020	4 (Faculty 2, Student 1, Postdoc 1)	5 (Faculty 4, Students 1)
2021	2 (Faculty 2)	4 (Faculty 3, Students 1)
2022	3 (Faculty 1, Student 2)	6 (Faculty 4, Students 2)

At the ANZIAM Conference 2021, A student in Kyushu University won the prize “TM Cherry Prize Honorable Mention” awarded to students who have made outstanding research presentations.

Shota Shigetomi (1st year, doctoral course, Graduate School of Mathematics, Japan)

Title: “Explicit formulas for motions of smooth/discrete elasticae”

In addition, the Japanese Society for Industrial and Applied Mathematics (JSIAM) is developing exchanges with ANZIAM as follows:

1. holding ANZIAM-JSIAM special session (September 2016).
2. conducted an exchange program with JSIAM at the ANZIAM Annual Meeting (February 2017).
3. organized and led the signing of a cooperation agreement between ANZIAM and JSIAM (March 2017).

9.5 Acceptance of FMfI Poster Award Winners

Students and academic researchers from overseas universities” who have won FMfI's Best Poster Award (including those from the Oceania region) are invited to IMI for research exchanges. Details are shown in Table 9.3.

Table 9.3 Acceptance of Students, etc. from Overseas Universities

FY	Name	Affiliation	Period
2016	Leah Price	PhD Student, Queensland University of Technology	2017/1/29 ~ 2/18
	Sanjib Mondal	PhD Student, The Queensland University	2017/2/27 ~ 3/16
2017	Rose Sierra Hart	PhD Student, University of Hawaii	2018/2/14 ~ 2/26
2018	Yunyoung Park	Postdoc, NIMS	2019/2/8 ~ 2/21
	Xiaolu Xu	Doctoral student, Dalian University of Technology	2019/2/12 ~ 2/24
	Yu Chen	Postdoc, Fudan University, Shanghai	2019/3/10 ~ 3/20
	Xiaoman Liu	Doctoral student, Southeast University	2019/1/31 ~ 2/13
2019	Seyd Mohsen Hashemi	Massey University	2020/2/1 ~ 2/16

In FY2015, FMfI accepted one faculty member (2 months) and three students (2 for 1 week and 1 for 3 months) from La Trobe University (supported by the JSPS Invitation Program for Foreigners) independently from the related invitations.

9.6 Joint Distance Learning

The Australian Branch began joint distance lectures at both IMI and La Trobe University in FY2020.

1st semester, FY2020

“Many-Sorted First-Order Model Theory”

Lecturers : Tomasz Kowalski (La Trobe University), Daniel M. Gaina, Yoshihiro Mizoguchi

1st semester, FY2021

“Many-Sorted First-Order Model Theory”

Lecturers : Tomasz Kowalski (La Trobe University), Daniel M. Gaina, Yoshihiro Mizoguchi

1st semester, FY2022

“Model Theory: mathematical foundations for specification languages”

Lecturers : Tomasz Kowalski (La Trobe University), Daniel M. Gaina, Yoshihiro Mizoguchi

1st semester, FY2023

“Model Theory: mathematical foundations for specification languages”

Lecturers : Tomasz Kowalski (La Trobe University), Daniel M. Gaina, Yoshihiro Mizoguchi

9.7 Other Activities

In addition to FMfI, several other research meetings have been held at IMI Australia Branch.

“Mathematics for Materials Science and Processing”

Dates : 2016/2/15 – 2/17

Venue : IMI Australia Branch (La Trobe University)

(Dispatched 17 faculty members and students; Total: 57)

Published 1 Lecture Note.

“Geometric Numerical Integration and its Applications”

Dates : 2016/12/5 – 12/7

Venue : IMI Australia Branch (La Trobe University)

Using the framework of Joint Usage and Research

(Total: about 24)

Published 1 Lecture Note.

“First Kyushu-UNSW Joint Workshop on the Mathematics underpinning Industry and Innovation”

Venue: University of New South Wales.

Six students from Kyushu University (four from IMI, one from the Institute of Bioregulatory Medicine, and one from the Graduate School of Agricultural Science) were dispatched.

• Four faculty members and one graduate student were dispatched as part of academic exchange. One joint research project was initiated.

• One speaker was invited to the JSIAM-ANZIAM Special Session at the JSIAM Annual Meeting.

“Differential Geometry, Lie Theory and Low-dimensional Topology”

<http://www.gygeom.com/>

Dates : 2016/12/19 - 12/21

Venue : La Trobe University

“Workshop on Big Data Analysis: a small workshop on big data”

<http://big-data-workshop.itumathstats.com/>

Dates : 2017/3/13 - 3/15

Venue : IMI Australia Branch (La Trobe University)

“From nano- to meso-scale: modelling materials and mechanisms”

Dates : 2017/1/12

Venue : IMI Australia Branch (La Trobe University)

“LAC2018”

<http://www2.math.kyushu-u.ac.jp/~lac2018/>

Dates : 2018/2/12 - 2/16

Venue : La Trobe University

“Mathematical Challenges to Infectious Disease”

The 1st Asia Pacific Online Seminars on Mathematics for Industry

Dates : 2020/9/11

Venue: (Online-Style)

Organizers: Dimetre Triadis, Kenji Kajiwara

“Statistics and Mathematical Modelling in Combination”

Dates: 2022/11/16 - 11/18

Venue: La Trobe University City Campus

10. Joint Graduate School of Mathematics for Innovation

This chapter provides a summary of the “Joint Graduate School of Mathematics for Innovation”. The details are described in the “Report of Activities” of the Institute. Please refer to the report for details of activities and achievements (written in Japanese).

<https://www.jgmi.kyushu-u.ac.jp/activity/publication/>

“*Joint Graduate School of Mathematics for Innovation*” (JGMI for short) is a joint graduate school established to implement the “Graduate Program of Mathematics for Innovation” (see below) of the Ministry of Education, Culture, Sports, Science and Technology (MEXT).

In a world where the demand for data science and AI is rapidly increasing, what is needed are professionals who can co-create across disciplinary boundaries and create innovations with free ideas and understanding, while using mathematics as an academic foundation, in the discovery and solution of issues latent in various scientific fields and in real society.

The Graduate School of Mathematics is a new type of educational and research institution in which the Graduate School of Mathematics, the Graduate School of Information Science and Electrical Engineering, and the Graduate School of Economics and Management collaborate and cooperate with each other, and faculty members from a variety of specialized fields participate to conduct education and research while co-creating with different fields of study.

The department will nurture outstanding mathematical modelers who can flourish in a wide range of fields based on mathematical modeling built on mathematical and statistical skills.

The Graduate School of Mathematics consists of a master's program (2 years) and a doctoral program (3 years), and awards a master's degree (in mathematics, technical mathematics, information science, science, engineering, academics, or economics) upon completion of the master's program, and a doctoral degree (in mathematics, functional mathematics, information science, science, engineering, academics, or economics) upon completion of the doctoral program. Students are selected from those who have passed the entrance examinations of the Graduate Schools of Mathematical Sciences, Systems Information Science, and Economics, which are the cooperative graduate schools, and after admission, students are classified into

the following categories: Mathematical Sciences, Systems Information Science, and Economics, respectively.

The university's commitment to organizational development with this program as a leading model will play an important role in raising students' awareness of the importance of interdisciplinary education and research and the needs of society. In addition, by working together with faculty members, researchers, and students in multiple fields on a daily basis, students can become more clearly aware of their own positions and open up various career paths, which is a great advantage for them. By bringing students from different fields together in a single organization, we expect to create a sense of unity among students from different fields and foster a sense of mission to respond to social needs that transcend the boundaries of their fields. It is with these principles in mind that this collaborative graduate school was established. This is the first time that a university selected for the "Graduate Program" (see below) has established an organizational system of interdisciplinary graduate school programs, including both public and private universities.

10.1 Graduate Program of Mathematics for Innovation

This program is a five-year degree program adopted by MEXT under the "Graduate Program" for Academic Year 2020. The objective of this program is to "foster outstanding doctoral students in mathematics who, based on their internationally outstanding mathematical and statistical skills, transcend organizational and disciplinary boundaries, utilize their mathematical modeling abilities to co-create and generate innovation in their respective fields".

The two major objectives of the *Graduate Program of Mathematics for Innovation* are as follows:

- To promote and lead the reform of graduate schools not only at Tohoku University but also in Japan by establishing and developing it into a world-class, interdisciplinary degree program that integrates master's and doctoral studies.
- To contribute to the development and traction of society and industry around the world by drawing out the potential of mathematics-for-industry in Japan and by making the program contribute to the enhancement of the quality and quantity of human resources with doctoral degrees in mathematics who can co-create with researchers in other fields.

In particular, students with excellent mathematical qualities and a desire to co-create with other fields of study are selected from among students who study mainly mathematics, systems information science, and economics, while developing their studies in the foundational disciplines,

- high and flexible “mathematical skills”,
- “Statistical skills”; essential for data handling,
- “Modeling skills” to see the essence of complex problems and build mathematical models,
- “Co-creativity” to collaborate with researchers in other fields and create,
- “Emergence” to create innovation by integrating the above four capabilities

The goal is to develop human resources with “Math-Five-Forces”, a set of capabilities that integrate the above four forces to create innovations.

The university-wide organization for the development of human resources for the future (the Education Reform Headquarters until FY2022) oversees the program, under which the Program Implementation Committee (the Faculty Council of JGMI) and the Program Steering Committee (the Steering Committee of JGMI) are formed, as well as the General Meeting consisting of all program personnel, and the Global Advisory Board consisting of external experts.

The Organization for Human Resource Development was established in April 2022 as a new organization to drive the improvement of the university's human resource development function by promoting integrated reform of the doctoral program, master's program, bachelor's program, and even high school level programs, with the aim of fostering world-class young researchers. The program was established in April 2022 as a new organization to lead the improvement of Kyushu University's human resource development function by promoting integrated reform of the doctoral program, as well as the master's and bachelor's programs and high school programs that precede the doctoral program, in cooperation with the President, Provost, and related directors. In particular, the Division of Doctoral Education Reform and Research Career Development within the program ensures collaboration with various doctoral education reform programs, such as the “Challenging Research Program for Next Generation Researchers” of the JST (Japan Science and Technology Agency).

The Program Implementation Committee, chaired by the program director and composed of program coordinators and faculty members in charge, is responsible for planning, application, implementation, management, reporting, improvement, proposal, and dissemination of the concept. The Program Steering Committee, as its subordinate organization, is responsible for flexible management.

The General Meeting consists of all program staff, including those from outside the university, to share information and exchange opinions on educational content and methods, etc., for the appropriate and smooth implementation of the program.

The Global Advisory Board consists of about 5 experts from outside the university, including foreigners and businesspeople, and provides opinions and suggestions from an international perspective on the educational content and methods of this program.

10.2 Partner Institutions

JGMI is developing projects in collaboration with various departments and institutions inside and outside Kyushu University, as well as with universities, research institutes, companies, and local governments outside of Japan.

The following is a list of the institutions with which we collaborate.

Faculty members in charge of the program are also selected from the following departments and institutions. For details, please refer to the report.

- Kyushu University Internal Affairs Bureau, etc.
- Graduate School and Faculty of mathematics
- Graduate School and Faculty of Information Science and Electrical Engineering
- Graduate School and Faculty of Economics
- Institute of Mathematics for Industry (IMI)
- Research Institute for Information Technology
- Pan-Omics Data Driven Innovation Research Center
- Research Institute for Applied Mechanics
- Medical Institute of Bioregulation
- International Institute for Carbon-Neutral Energy Research (I²CNER)
- Faculty of Arts and Science
- Faculty of Medical Science
- Kyushu University Hospital
- Faculty of Law
- Faculty of Design
- Faculty of Engineering
- Faculty of Agriculture
- Faculty of Science

- Domestic institutions outside Kyushu University
- The Institute of Statistical Mathematics
- National Institute of Advanced Industrial Science and Technology (AIST)
- RIKEN

- Overseas Universities
- University of Illinois at Urbana-Champaign
- National Taiwan Normal University
- University of California, San Diego

Leiden University
La Trobe University
Zuse Institute Berlin
National University of Singapore

• Domestic corporation

Fujitsu Laboratories, Fujitsu Limited
Sumitomo Electric Industries, Ltd.
Mazda Motor Corporation
NTT (Nippon Telegraph and Telephone Corporation)
Beautiful Mind Inc.

• Municipality

Itoshima City

10.3 Support System

In order to promote the development of mathematics doctoral human resources with “Math-Five-Forces”, JGMI has introduced the following support system.

• Multi-Mentor System

The Graduate School of Mathematics has established a “Multi-Mentor System”, in which multiple faculty members provide research guidance to students. Through this system, which provides extensive support from entrance to exit, we mainly cultivate students' creative abilities. The system consists of “Research Mentors”, who are conventional supervisors; “Co-Creation Mentors”, who are program directors in fields different from the main research fields in mathematics; “Global Mentors”, who are prominent researchers from overseas research institutions; and “Young Mentors”, who are post-doctoral researchers in mathematics, information science, and economic engineering. There are also “Practical Mentors” who are researchers in private companies, research institutes, or local governments.

• Financial Support

In addition to the “Tuition Support Grant” and “Excellence Incentive Grant” fully paid by Kyushu University, JGMI provides various support systems such as “Travel Expense Support” for various academic activities, free English conversation study support to develop international human resources, and “International Support” as represented by the Study Abroad Support Program.

・Doctoral Program for Outstanding Working People

This program is the first of its kind in Japan, designed to resolve issues such as economic circumstances and career development, which are the main reasons for Japanese students to give up on doctoral studies, and to foster doctoral human resources through the cooperation of this program and companies.

Under this program, companies hire outstanding students after they complete the first year of the master's program (or after they finish the first year of the doctoral program), and at the same time, they advance them to the doctoral program as working students. In other words, while receiving a salary from the company, the student can conduct research as a doctoral student. After obtaining the doctoral degree, the students continue to be employed by the company. Doctoral students who were employed in 2022 and have been enrolled as working adult doctoral students since then.

10.4 Curriculum

Courses in this institute are classified into the following five categories, and students in this institute will take courses in each category to pursue the path of math-for-innovation professionals. A brief flowchart of the curriculum is shown in Figure 10.1.

Figure 10.1 Curriculum of the JGMI: Flowchart
(Extracted from the 2022 Activity Report, in Japanese)



- **Basic Courses**
Courses that provide students with a wide range of mathematical, statistical, and other theories necessary for mathematical modeling, from the basics to applications.
- **Transition Courses**
Transition courses are designed to provide students who have not taken mathematics as part of their undergraduate education with the basic knowledge and concepts of mathematics so that they can smoothly transition to specialized education in mathematics in the master's program.
- **Internship Courses**
Courses in which students conduct research and R&D work in laboratories in the field of co-creation research (other than their own specialty), at universities, research institutes, and private companies in Japan and abroad.
Courses also include courses in which students are dispatched to faculty members in other fields to spread the know-how of co-creation with other fields within the university and provide guidance to faculty members and students in other fields.
- **Presentation Courses**
Courses in which students prepare an interim report and give an oral presentation on the contents of the report, focusing on their achievements up to the second year of the doctoral program.
- **Research Courses**
Courses in which students aim to write a dissertation based on the results of a research project in their field of specialization or a related research field under the supervision of a research advisor.

10.5 Other Activities

Study Group Workshop and FMfl, which IMI is proactively involved in organizing every year, are official events of JGMI, and are effectively used for education related to interdisciplinary cooperation and international activities.

10.6 Number of Applicants

The number of applicants to date has remained as shown in Table 10.2, indicating that the program is attracting excellent students.

Table 10.2 Number of Applicants to JGMI

	FY2021	FY2022	FY2023	Total
Master	28 (Capacity 14)	13 (Capacity 12)	21 (Capacity 12)	62 (Capacity 38)
Doctor (Skipping grades)	5 (Capacity 4)	7 (Capacity 2)	3 (Capacity 2)	15 (Capacity 8)
Total	33 (Capacity 18)	20 (Capacity 14)	24 (Capacity 14)	77 (Capacity 46)

11. Post-AIMaP

IMI has been operating until March 31, 2022, as the lead center of *AIMaP; Advanced Innovation powered by Mathematics Platform* (FY2017-FY2021), a project funded by the Ministry of Education, Culture, Sports, Science and Technology of Japan (MEXT). After the completion of AIMaP, the activities have been continued as “Post-AIMaP” activities in collaboration with IMI and the cooperating centers.

This chapter outlines the AIMaP and Post-AIMaP activities.

11.1 AIMaP

AIMaP is an organizational effort to promote collaboration between mathematics and mathematical sciences and various scientific fields and industries, based on the network infrastructure for research activities established by “The Cooperation with Mathematics Program” (commonly called “The *Coop-with-Math Program*”, core organization: The Institute of Statistical Mathematics, 2012 - 2016), aiming at research promotions for the creation of innovation through collaboration between mathematics and mathematical sciences, other sciences, and industry. The IMI serves as the executive director, and an all-Japan structure has been established with 12 institutions of mathematics and mathematical sciences throughout Japan as cooperating centers.

The purpose of this project is to proactively identify potential needs for mathematics and mathematical sciences (problems that are expected to be solved by the use of mathematics and mathematical sciences) in industry and various scientific fields, focusing on fields and industries where the use of mathematics and mathematical sciences may lead to innovation, and to promote collaboration with mathematics and mathematical science researchers who are suitable for solving such problems. The objective is to establish a mechanism to promote

research in collaboration with researchers in mathematics and the mathematical sciences, utilizing a nationwide network.

AIMaP aims to build an all-Japan framework with IMI as the lead institute and 12 research institutes in mathematics and mathematical sciences as cooperating centers, to actively identify potential needs in mathematics and mathematical sciences, and to establish a mechanism to promote collaborative research with researchers in mathematics and mathematical sciences, the following activities are operated:

- Implementation of appeal plans in line with priority collaboration fields,
- Matching activities between the seeds of mathematics and mathematical sciences and social needs through technical consultation services,
- Building a nationwide network of executive centers and cooperating centers.

The result of these activities was the establishment of a nationwide network of 13 centers. As a result, a strong network system was established among 13 centers and with three mathematical and mathematical science societies (the Mathematical Society of Japan, the Japanese Society for Industrial and Applied Mathematics, and Japanese Federation of Statistical Science Associations), and 127 appeal projects were implemented on this basis. AIMaP has also been able to initiate (or is expected to initiate) 71 joint research projects between mathematics and mathematical sciences and industry and other scientific fields.

The final report and other documents are available on the AIMaP website at <https://aimap.imi.kyushu-u.ac.jp/wp/category/news/> (written in Japanese).

11.2 Post-AIMaP

After the completion of the AIMaP project, the Post-AIMaP activities (*π Map activities*) represented below will be continued to maintain and further develop the platform that is being established to promote collaborative research with various scientific and industrial sectors. Based on these activities, the “*Post-AIMaP (π MaP) Declaration*” was formulated and published. Details are provided in the final report.

Below is a summary of Post-AIMaP activities and their main aspects.

1. Appeal activities

To the extent possible, each center will continue to carry out promotional activities. If budgetary

support is required, the framework of Joint Research Center (Chapter 5) in IMI will be used. In addition, collaboration with the three academic societies will be promoted through appeal projects and the center's steering committee meetings.

Detailed materials are in the Appendix of the report.

2. Maintenance of the network system

To maintain the nationwide network established through the AIMaP project as an organized management system, a list of contact persons at each center will be prepared and managed by IMI. Information and opinion exchange meetings, including technical consultations, will be held regularly to maintain information sharing and to coordinate joint research among the collaborating centers.

3. Technical Consultation Service

The person in charge of industry-academia collaboration at IMI of Kyushu University will continue to collect needs from companies, etc., and will continue to collaborate with the technical consultation counter of the cooperating center. Table 11.1 shows a list of contacts made in FY2021.

Table 11.1 List of contacts to companies by AIMaP coordinators in FY2021
(Extracted from the FY2021 Performance Report of AIMaP, in Japanese)

業種	コンタクト	オンライン 打ち合わせ	企業にて 課題探索	企業にて具体的な 課題について相談検討中
材料・部品	35	8	3	3
電機	21	2	2	2
輸送機器・機械	6	1	1	1
教育	1	1	1	1
調査・コンサルティング	9	1	0	0
研究機関（非大学）*1	6	0	0	0
情報・通信	4	0	0	0
機密機器・製造装置	3	1	0	0
建設	2	0	0	0
その他*2	7	0	0	0
件数*3	98	14	7	7

*1: Research institutions (non-university): private research institutes, public foundations, general foundations, national research and development corporations, etc.

*2: Others: General trading companies, automobile manufacturers, electric power companies

* 3: Duplicate counts of contacts to different departments/persons in the same company (omitted)

4. Human Resource Development Activities

In collaboration with C-ENGINE (see Section 6.16), we will gather information on the needs of companies through internships and establish footholds for study groups, workshops, joint research, etc., while deepening understanding of the usefulness of mathematics and mathematical science, fostering young research personnel who will lead future collaborations and human resources who can make use of mathematics in the field of business.

5. Initiative for Industry-Academia Collaboration in Mathematical Applications with The Japan Business Federation (Keidanren) and the mathematics community have launched the “Industry-Academia Collaboration Initiative for Mathematical Applications” as a framework for exploring new forms of industry-academia collaboration in mathematical applications in industry and have held several meetings mainly online. By positioning this framework as one of the Post-AIMaP projects and actively cooperating with it, we will promote the creation of the soil in which mathematics and mathematical science can contribute to generate innovation in the industrial world.

The actual activity was focused on sharing collaborative activities that continued from AIMaP, which took place over two “information exchange meetings”. As of October 2023, the Post-AIMaP activities were taken over by the following “Mathematics-for-Industry Platform”.

11.3 Mathematics-for-Industry Platform (MfIP)

The above Post-AIMaP activities were taken over by the “*Mathematics-for-Industry Platform*” (“*MfIP*” for short) of the “Division of Strategic Liaison” newly established at IMI in FY2023.

The platform is a system that responds to the needs of society, industry, and various fields in the mathematics community as a whole by networking with openly solicited joint-use researchers from other joint research centers and utilizing study groups and workshops, which are organized PBL-type research. In line with the establishment of this system, the following activities will be carried out.

- “Establishment and operation of the IMI Tokyo Branch”. The IMI Tokyo Branch will overcome geographical disadvantages and aim for effective collaboration with industry, government, and academic institutions, as well as the securing of human resources.

- “Technical Consultation Network”. Sharing and matching of joint research themes throughout the MfIP. As with the Post-AIMaP technical consultation service, senior personnel from universities and companies will be put in charge of this service.
- “Collaboration with JGMI (Chapter 10)”. Support and matching of cross-disciplinary research for regional development will be provided by utilizing the network with the linked academic institutes. In addition, “Systematization and standardization of the mathematics-for-industry curriculum” will be carried out. This will be provided (for a fee) to researchers and others in industry for use in recurrent education. The goal is to increase the number of researchers who can use mathematics practically in industry.

General Comments and Editorial Postscript

This report summarizes the projects that IMI has undertaken since its establishment and the achievements it has accumulated. Although we have not been able to survey all the details, as we have discussed, IMI's efforts and accomplishments are diverse. On the other hand, this report has also revealed issues that are not usually brought to the surface, and we would like to discuss them again here.

As mentioned earlier, since its establishment, IMI has been involved in various projects in research, industry-academia collaboration, and education. On the other hand, this is the first time since its establishment that IMI has prepared a document reporting its achievements. While the IMI has compiled reports summarizing each of the projects it has undertaken, such as “*Joint Research Center for Advanced and Fundamental Mathematics-for-Industry*”, “*Joint Graduate School of Mathematics for Innovation*” (JGMI) and “*AIMaP*”, there has not been a summary of the IMI's overall projects. At this point, we can see one aspect of IMI at this point. Although IMI is a research institute, it was established as a partial split from the Faculty of Mathematics and has the same structure as a normal research institute with a mission of education and research. Therefore, the management of the IMI has been carried out by the administrative office of the Faculty of Science and a small office (Mathematics and IMI Office), which has the same structure as that of the Director and other faculty members in the executive committee and the general classroom office. In other words, IMI did not have its own function in charge of “*management*”, and the workload was directly related to the faculty members. This has no small impact on research activities and student guidance. The lack of a management function obscures IMI's projects, its achievements, and its standing, and there is a danger that the control function will not work even if there is a serious lack of balance in its operations.

Furthermore, even though IMI has a “Division System”, it is difficult to say that management is carried out by departments, and the reality of “divisions” at IMI is an aggregation of individual researchers. Some departments have specific budgets, but even these are often “aggregations of individuals. There is no mechanism in place to indicate and evaluate whether each department can carry out activities that embody its own philosophy. While individual researchers can demonstrate the sustainability of demand through their research activities, the organization as an aggregate of these researchers, especially the divisions, are unable to clearly demonstrate their *raison d'etre*, and their *raison d'etre* is in doubt as to whether they should be sustained within IMI or not. Despite this, there is no clear function that holds or makes departments accountable. Even if it exists, it is not shared within the IMI. One could argue that due to the fluidity of the field in accordance with the needs of society, the divisions that should exist are also flexible, but the accountability is concentrated in the director and the executive office and not in the members of the divisions. We believe that the time has come to reconsider the nature of “division system” and the operations based on it.

On the other hand, the management of IMI, which is an academic and also a mathematical research institute with a very special position, is not without its share of difficulties in operation, as the details cannot be grasped without personnel who are well versed in the field. This differs from the I²CNER (International Institute for Carbon-Neutral Energy Research), which has an independent management department as a “support department” based on administrative staff (Note: The author of this summary is also a member of the I²CNER). The creation of the “Division of Strategic Liaison,” which specializes in management, was inevitable in the current situation where IMI is being called upon by society to strengthen its functions. We believe that the significance of this report is not only in summarizing the results of the IMI, but also in revealing the current status of the IMI as described above. As a supplementary note, this report was compiled as part of the Division of Strategic Liaison's project.

The following are minor points that were keenly felt during the preparation of this report and that we believe should be improved. The following are some of the minor points that were keenly felt during the preparation of this report, and which we believe need to be improved. This is an issue not only for IMI but also for Kyushu University as a whole. First of all, the various data presented here have been collected since the establishment of IMI and are the result of the great contributions of the people involved in mathematics and the IMI office. In the process, some of the data reached outside of the IMI office, such as the administrative offices of the Faculty of Science and the Academic Research and Industrial Collaboration Management Office of Kyushu University (AiRIMaQ for short), and the exchange of data did not go smoothly in many cases. While this can be attributed in large part to a lack of know-how due to a lack of

experience in report preparation, the part that caused the most headaches were the drastic change in the administrative structure that began in mid-2015. In FY2009, the Graduate School of Mathematics moved from Hakozaki to Ito, and with the move, the administrative department under its jurisdiction was transferred from the Administrative Department of the Faculty of Science to the Administrative Department of the Faculty of Comparative Studies for Society and Culture. This was due to the loss of a large amount of data during this transition period. This was due to the fact that each administrative department had its own independent management system. Although this is a past event, it exposes the weakness of the management system in data management. Considering the possibility that the loss could have been avoided if there had been closer cooperation among the administrative divisions, the cooperation system cannot be said to be strong. Weaknesses in the administrative structure can be attributed to a variety of reasons, including limitations due to staff shortages. Those in charge of management (whether clerical or faculty, in the science department, AiRIMaQ headquarters, or the entire university) should be aware of the current status of the administrative structure and work to develop optimal measures on a case-by-case basis.

Similarly, “centralization of information dissemination and collection means” is another point that should be strongly considered in organizational management. This report was compiled based on the information sources mentioned in the main text, but there is a discrepancy with the reports of the Joint Research Center (for internal use only), which compiles detailed reports, making it difficult to organize the information. This is largely due to the fact that the collection of information relies on “self-reports by each faculty member”, and the form of collection and the type and timing of information differ. Taking research achievements such as papers as an example, input through Q-RADeRS, the university-wide database, and data collection at the Joint Research Center are conducted separately. Thus, faculty members are required to organize and provide similar information twice (or more if another opportunity arises). On the other hand, the administrative department is required to organize information that cannot be distinguished unless they are familiar with academic activities, such as the existence of duplications, distinction of categories of achievements, and so on. Another confusing factor is the lack of uniformity in data entry information. This is particularly apparent in information presented at academic conferences. In Q-RADeRS, the data information source, “conference presentations” are to be entered, but each faculty member has a different perception of the categories of “seminars,” “research meetings”, and “domestic or international”, which are counted as achievements in the mathematical sciences, and there is no sense of unity. Therefore, if the categories are strictly organized, there is a large possibility that some faculty members will add information to the list while others will not, which inevitably raises questions

about the credibility of the data. Considering the particular nature of mathematics-related activities, which also emphasize inter-community activities such as seminars, it is unrealistic to ask the Q-RADeRS design itself to be changed in this regard, so we will have no choice but to unify “what information to input” within IMI and put it into practice. In any case, a mechanism to manage information centrally within the IMI is essential to ensure transparency and credibility of projects and results and is a part of the IMI that has been lacking to date.

In addition, this report is compiled based on the information managed by Q-RADeRS and each administrative department and summarizes results mainly from publicly available information. However, faculty members and administrative staff spend a significant amount of their time on legal work, including work related to entrance examinations, contracts for industry-university collaboration, reports, and various meetings that are not included in this report. Especially for faculty members, the increase in various tasks has a serious impact on the reduction of their research time. Therefore, it is necessary to review all the tasks and projects they have undertaken, including data compilation, and to establish a “unified structure and standards” to guide their activities.

All of these problems and areas for improvement are associated with “organizational management”. IMI has accumulated unique achievements that cannot be seen anywhere else in Japan, but this is largely due to the awareness of the issues and individual skills of each faculty member. Therefore, I believe that IMI will become a solid organization that deepens and develops mathematics and mathematical sciences while responding to the needs of society and its responsibilities, if it does not rest on its past achievements and continues to grow without neglecting to solidify the foothold that supports the organization.

Finally, as I mentioned earlier, this report is based on the vast amount of data collected, scrutinized, and compiled by the members of the Mathematics and IMI Office in the gaps between their normal duties. Without their significant contributions, this report would not have been published. I would like to take this opportunity to express my sincere gratitude to all those who contributed to this report, and I hope that this report will serve as one of the foundations for the further development and sustainability of IMI as an organization, which is the greatest contribution that this report can possibly make.

Responsibility for wording of an article:
Kaname Matsue (Professor, Division of Strategic Liaison)